FIFTH ANNUAL REPORT SAN FRANCISCO OAKLAND BAY BRIDGE

THE GREAT SEAL OF THE STATE OF CALIFORNIA

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This copy of the Fifth Annual Report of the San Francisco-Oakland Bay Bridge as of July 1, 1938, which has been published to provide the authorities having interest therein with a complete record thereof, is issued to

....

GOVERNOR CULBERT L. OLSON

Chairman, California Toll Bridge Authority

FIFTH ANNUAL
REPORT
SAN FRANCISCO
OAKLAND
BAY BRIDGE

. . JULY 1, 1938 . .

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Note—

❡ This is Volume V of a series of annual reports on construction progress and operation of the San Francisco-Oakland Bay Bridge and its railway facilities.

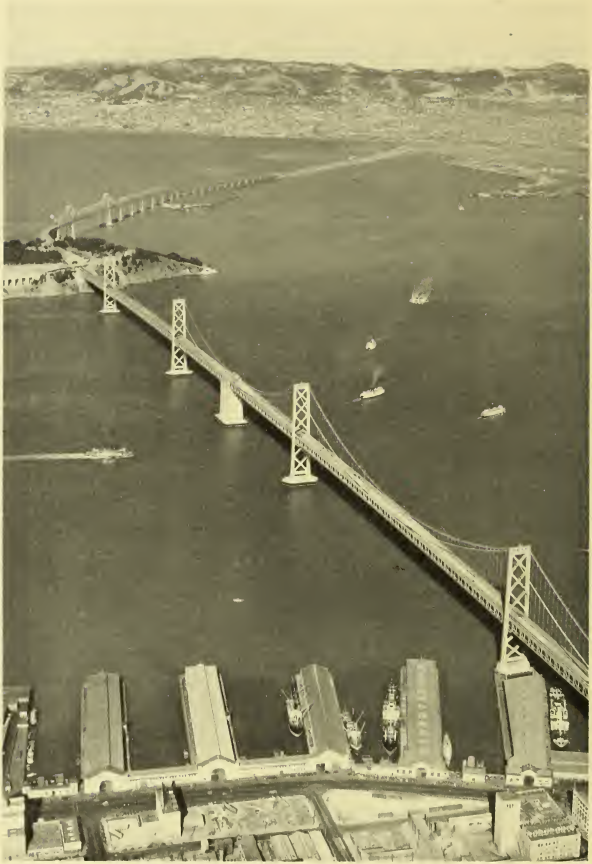
❡ Volume I contained material on legislation, financing, preliminary design, general description, and construction progress to June 30, 1934.

❡ Volume II told of construction developments from July 1, 1934, to June 30, 1935.

❡ Volume III continued construction progress from July 1, 1935, to June 30, 1936.

❡ Volume IV described completion of construction of the Bridge; the start of construction on the Bridge Railway and told of operations and maintenance for the fiscal year July 1, 1936, to June 30, 1937.

❡ Volume V contains a report of construction progress on the Bridge Railway and operation and maintenance of the Bridge for the fiscal year July 1, 1937, to June 30, 1938.



Aerial View San Francisco-Oakland Bay Bridge

THE
SAN FRANCISCO–OAKLAND
BAY BRIDGE

Designed and Constructed by the DEPARTMENT OF PUBLIC WORKS *of the* STATE OF CALIFORNIA *for the* CALIFORNIA TOLL BRIDGE AUTHORITY

CALIFORNIA TOLL BRIDGE AUTHORITY: Culbert L. Olson, *Governor;* Ellis E. Patterson, *Lieutenant Governor;* Frank W. Clark, *Director, Department of Public Works;* Phil S. Gibson, *Director, Department of Finance;* Lawrence Barrett, *Chairman, California Highway Commission.*

SAN FRANCISCO-OAKLAND BAY BRIDGE DIVISION OF THE DEPARTMENT OF PUBLIC WORKS: Frank W. Clark, *Director;* C. H. Purcell, *Chief Engineer;* Charles E. Andrew, *Bridge Engineer;* Glenn B. Woodruff, *Engineer of Design.*

RECONSTRUCTION FINANCE CORPORATION—BOARD OF DIRECTORS: Jesse H. Jones, *Chairman;* Henry Morgenthau, *Secretary of the Treasury, ex officio;* Charles B. Henderson; Howard J. Klossner; C. B. Merriam; Emil Schram; George R. Cooksey, *Secretary*; H. A. Mulligan, *Treasurer*; Claude E. Hamilton, Jr., *General Counsel*; Morton Macartney, *Chief, Self-Liquidating Division*; Frank W. Kuehl, *Counsel*; W. L. Drager, *Chief, Engineering Section.*

BOARD OF CONSULTING ENGINEERS: Ralph Modjeski, *Chairman*; Moran and Proctor; Leon S. Moisseiff; Charles Derleth, Jr., H. J. Brunnier.

BOARD OF CONSULTING ARCHITECTS: Arthur Brown, Jr.; John J. Donovan; Timothy L. Pflueger.

CONSULTING GEOLOGIST: A. C. Lawson.
ATTORNEYS: Keyes and Erskine and Edward P. Murphy.

To His Excellency, **CULBERT L. OLSON,** *Governor of California,*
and Members of the California Toll Bridge Authority

GENTLEMEN:

Transmitted herewith is the Fifth Annual Report of Charles H. Purcell, Chief Engineer of the San Francisco-Oakland Bay Bridge.

The report contains an account of the construction of Bridge railway facilities for the fiscal year July 1, 1937, to June 30, 1938. It also describes operation and maintenance activities of the Bridge for the same period.

The Department of Public Works and the Division of Highways take pleasure in forwarding this report for your consideration.

Respectfully submitted

Frank W. Clark

FRANK W. CLARK
Director of Public Works

To the Honorable **FRANK W. CLARK,** *Director of Public Works*
of the State of California

Sir:

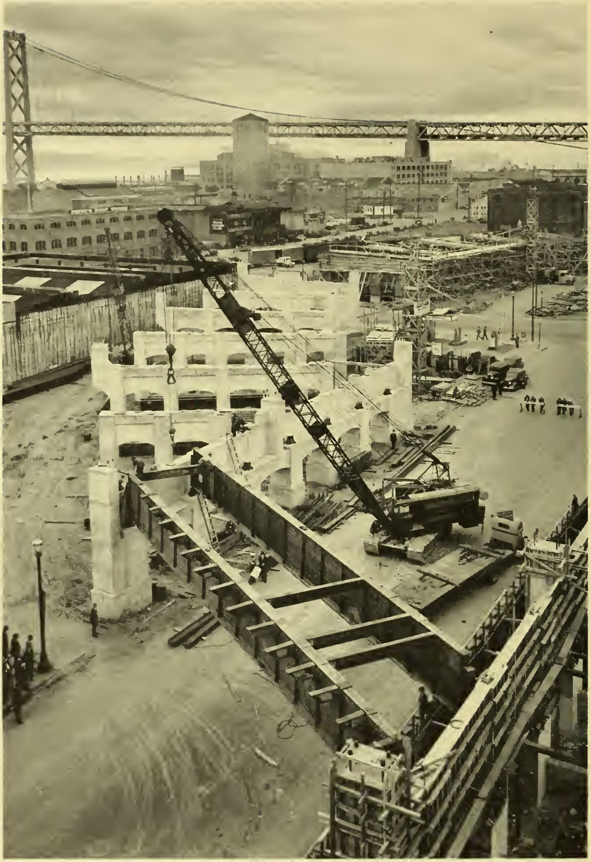
There is submitted herewith the Fifth Annual Report of the San Francisco-Oakland Bay Bridge covering the fiscal year July 1, 1937, to June 30, 1938.

Under the section "Part One, Construction" there is an account of the structural progress of the Bridge Rail System, and minor items of general construction having to do with the Bridge proper.

The section "Part Two, Operation and Maintenance" contains an account of the financial status; a report of the effects of automobile ferry competition and general administrative problems involved in the operation of the Bridge.

Respectfully submitted

C. H. PURCELL
Chief Engineer



Steel Erection
Beale Street Crossing,
March 2, 1938

FIFTH ANNUAL PROGRESS REPORT

. . . PART I . . .

CONSTRUCTION

Bridge Railway Facilities

Summary

Although in the original design for the San Francisco-Oakland Bay Bridge space had been provided for two interurban railway tracks on the south side of the lower deck, nothing could be done toward constructing operating facilities until agreements had been reached with the railways contemplating the use and maintenance of the system.

The California Toll Bridge Authority, in the public interest, required that terms of the agreements with the carriers were such as to receive the approval of public officials in San Francisco and Alameda County cities.

Rail Agreements Completed

The result was that the number of public hearings, and conferences and the prolonged periods of negotiation were so extensive that final agreements were not completed until March 6, 1936, between the California Toll Bridge Authority and Interurban Electric (a Southern Pacific subsidiary) and Key System.

It was then necessary to conclude arrangements with the Reconstruction Finance Corporation for financing of railroad construction. Funds were not available for the purchase of property until the fall of 1936.

Definition

The Bridge Railway, as defined in the agreement between the Authority and the carriers, consists of the San Francisco Terminal and viaduct and all tracks and appurtenances, between the terminal and connections with the existing lines in Alameda County. It includes also storage tracks in the East Bay yard; the complete power distribution system, except substations; the signal system; telephone system; inspection buildings in the East Bay yard and all incidentals to provide complete facilities for electric interurban service.

The Authority is further providing funds for such alterations to the equipment of the railway companies as are necessary for bridge operations.

Operation of Sacramento-Northern electric trains across the Bridge is also contemplated.

Toll for Rail Facilities

For use of the facilities the carriers are to pay to the California Toll Bridge Authority a toll estimated at two and one-half cents per passenger. Certain properties and equipment were also ceded to the Authority.

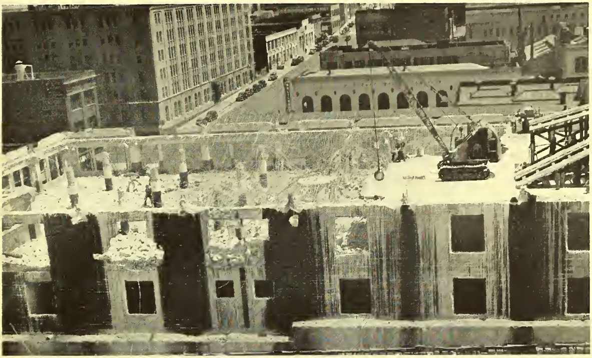
(Refer to Volumes II, III, and IV.)

Demolition for San Francisco Terminal

⟦Contract No. R-1A⟧

Status of Work June 30, 1937

Work on the contract for this project was practically completed by the end of the last fiscal year. (Refer to Volume IV.)



Operating Ball Ram, July 5, 1937

General

The project included the demolition and removal of buildings on thirty-four parcels of land, involving structures on certain parcels required for viaduct construction, in addition to major buildings for the terminal site.

Construction

Conventional building razing methods were employed. Properties were first stripped of all salvageable small materials and walls and floors were then collapsed into the center of each unit. Bricks and debris were removed with power equipment.

Razing Methods

Brick and concrete walls were razed by a method new to this locality. Crane operated ball rams were used for this work substituting for hand and air equipment.

Personnel

Work under this contract was executed by the Cleveland Wrecking Company of Cincinnati, Ohio. Charles H. Rose, vice president, was in charge of the project for the contractor.

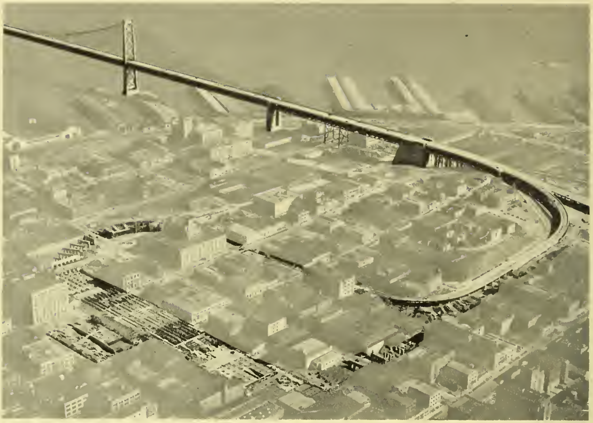
N. W. Reese was resident engineer for the State.

Summary

Contract was awarded December 1, 1936. Work started December 21, 1936. The contract was completed August 9, 1937.

Costs

By supplementary agreement, this contract was extended with a total cost of $121,175.00.



Bridge Rail Approach and Terminal, March 8, 1938

San Francisco Terminal

⟦Contract No. R-2⟧

Status of Work, June 30, 1937

Demolition operations had not been completed sufficiently before the end of the fiscal year to start construction on the project.

General

Although some discussion of the terminal has been given in previous reports (Volumes III and IV), it is expedient here to describe the structure in greater detail.

Principles Controlling Design

Design of the terminal was governed by the controlling principles of convenience to the passenger and an architectural treatment that was suitable to a public building in a metropolis. The development of these principles led to a design differing from the conventional railroad terminal to such an extent that the structure may be considered a system of enclosed ramps and stairs providing the shortest path from any of the adjacent streets to the various trains on the elevated track level.

For this purpose, the vertical distance from the street to the track level was kept as low as possible even though it involved lower ceiling heights than would otherwise have been used. Total vertical distance from track level to street level is twenty feet.

Street cars are to be brought to the mezzanine level on a ramp in front of the building, requiring a vertical distance of only ten feet between train and street car levels.

The Terminal Building will have a total length of 870 feet, extending ninety-five feet east of Fremont Street to a point 300 feet west of First Street. It is partially divided by these two streets into three units, termed respectively the east, center and west units. The track level, however, or third floor, extends over these streets, connecting all three units by a common floor.

Each unit has a basement, first, mezzanine and track floor. The first floor is at street grade, and the center unit is to be utilized as a waiting room, with rest rooms and concessions. Store space has been provided for the street floors of the east and west units. The second, or mezzanine, floors are to be used as transverse concourses in all three units, giving access to all tracks. The east and west units are each 164 feet wide and the center unit is 197 feet wide.

Terminal Tracks

Provision for six tracks will allow each train to remain five minutes in the terminal, affording ample time for loading and unloading and providing leeway for off-schedule trains. It will also permit a definite allocation of space to each train so that the passenger will always find his train at the same location under normal conditions.

The three northerly tracks (Numbers One, Two and Three), are to be assigned to the Interurban Electric; the three southerly tracks (Numbers Four, Five and Six), to the Key System. Sacramento Northern trains, according to plans, will use Track Number Six.

Concession Space

In addition to the facilities required strictly for passenger service, provision has been made for concessions usually associated with such a terminal. Since it was considered expedient to give the concessionaires all possible leeway in finishing and furnishing their concession areas, this work was not included in the terminal project. However, restrictions require that concessions shall be finished in harmony with the building's architectural design.

Garage space for more than 600 cars has been provided in the basement, street and mezzanine floors of the west unit and in the basement of the center unit. In addition, there is an area for a considerable amount of outdoor storage.

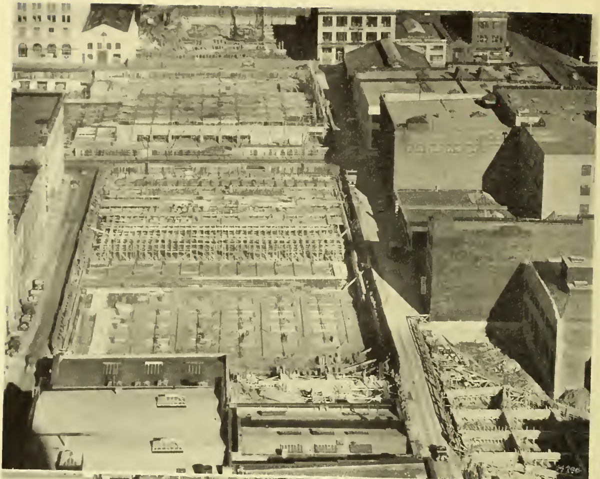
The railroad companies will act as agents for the California Toll Bridge Authority in leasing the concessions, but all leases must be approved by the Authority. Income from the concessions will go to the Authority.

Noise Reduction Methods

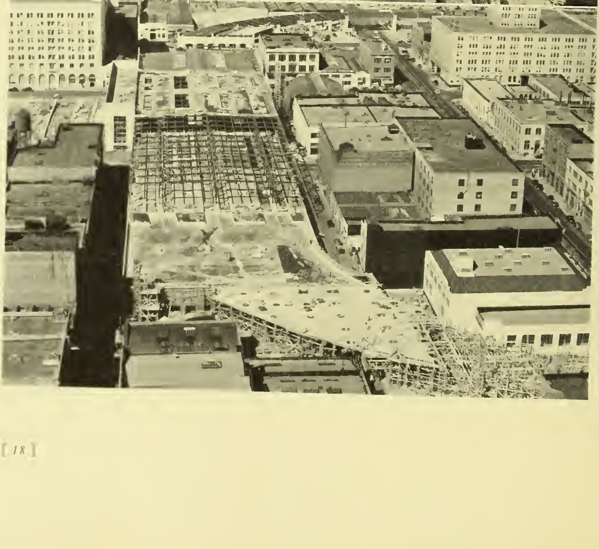
Except for the rigid steel frames supporting the tracks over First and Fremont Streets and those over the track level, the terminal will be of flat-slab reinforced concrete construction. To reduce noise of trains entering and leaving the structure track ties will be embedded in concrete which will be insulated by a two-inch cushion from the remainder of the construction.

Simplicity is the keynote of the architectural treatment. The Mission Street facade will be of granite. Interior treatment calls for plastered ceilings painted an off-white; tile walls and terrazzo floors.

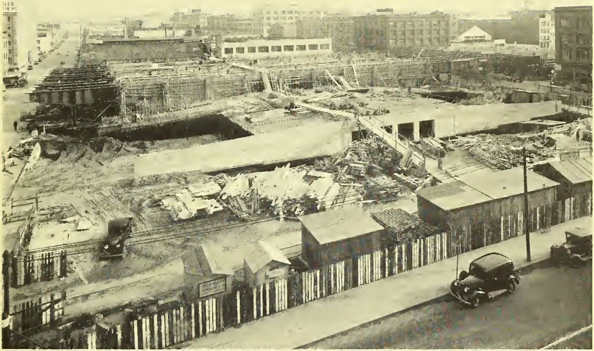
Contracts for the terminal construction were let under four units, as follows: General Construction, Contract R-2A; Structural Steel, Contract R-2B; Mechanical Work, Contract R-2C; Electrical Work, Contract R-2D. Construction progress on these contracts are discussed under their respective heads.



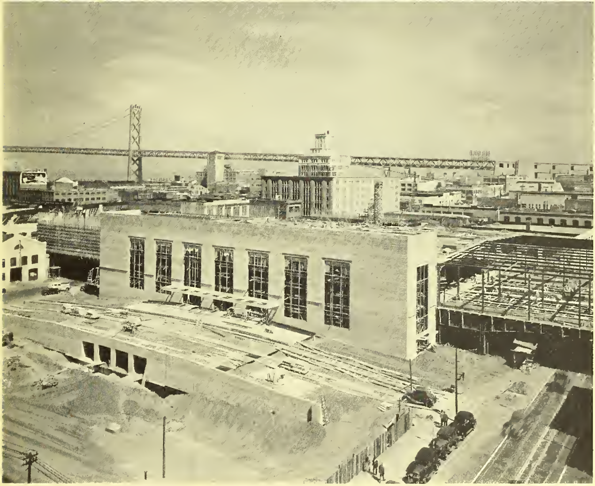
Terminal Construction, December 22, 1937



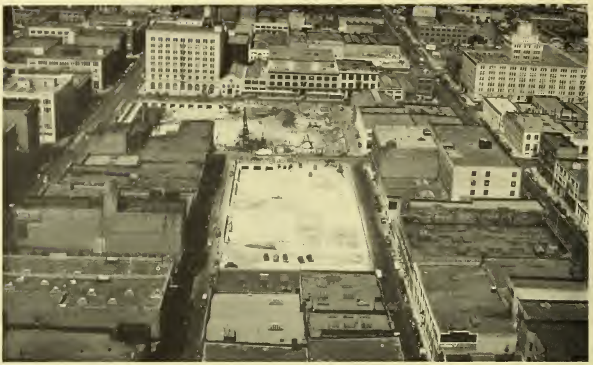
Terminal Construction, May 3, 1938



Front View of Terminal, February 21, 1938



Front View of Terminal, May 13, 1938



Start of Foundation Construction, San Francisco Terminal, August 6, 1937

General Construction (Contract No. R-2A)

This contract was awarded to MacDonald and Kahn Company of San Francisco July 16, 1937, on a bid of $1,658,510. (Refer to Volume IV, Tabulation of Bids.)

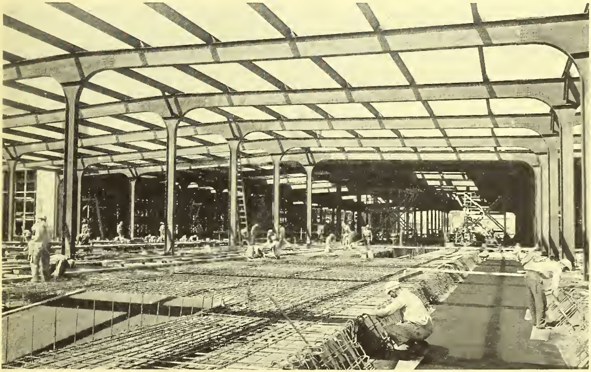
By July 22, 1937, the site of the center unit had been cleared to the extent required for the start of excavation. As soon as sufficient excavation progress had

Basement Ramp, San Francisco Terminal, December 7, 1937

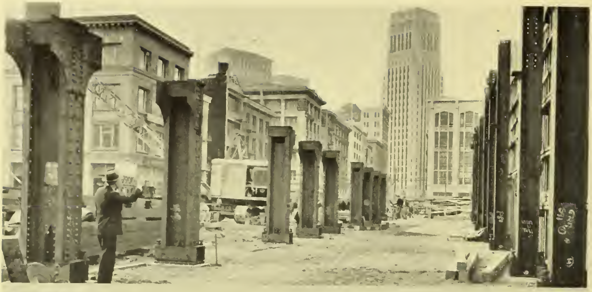
Interior View of Headhouse, San Francisco Terminal, June 21, 1938

been made, pile driving operations were started. These operations were prosecuted in successive stages in the center, west and east units in the order named.

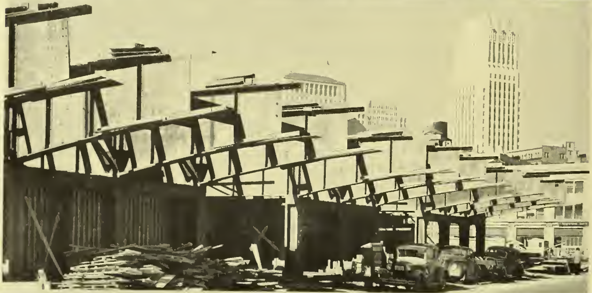
Concreting followed immediately upon completion of the foundations. Conventional methods were used in all operations. Interior finish operations were synchronized with concrete construction.



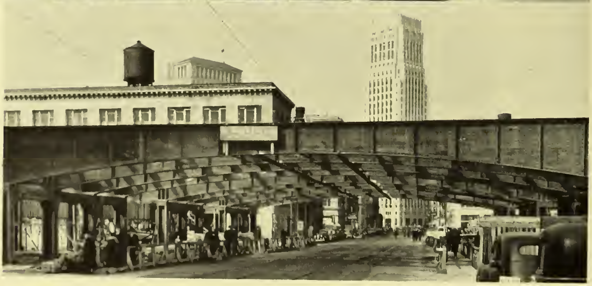
Track Level Construction, San Francisco Terminal, May 13, 1938



*onstruction Progress
Steel Overhead at
First Street,
January 15, 1938*



February 12, 1938



February 21, 1938

Status of Work to Date

Concreting has been completed up to and including the track floor in the terminal and in the westerly viaduct section. The roof over the track level is ninety-five per cent completed and work on the interior finish is seventy per cent completed. Only major concrete operation remaining to be finished is the deck of the easterly viaduct section.

Personnel

Felix Kahn is president of MacDonald and Kahn Company; Dallas Young is construction superintendent for the contractors.

N. W. Reese is resident engineer for the State on this contract and the following related contracts for the terminal.

Structural Steel (Contract No. R-2B)

Viaduct Steel

This contract covers the furnishing and erection of structural steel for the street crossings at First and Fremont Streets in the terminal, the structural supports for the roof of the building and steel for the following sections of the viaduct: east and west crossings of Howard Street; north and south crossings of Beale Street; steel viaduct between the Beale Street crossings; and the south First and south Fremont Street crossings.

Included also under this contract is the furnishing and erection of steel for the catenary bridges for the viaduct.

The contract was awarded to the Columbia Steel Company July 16, 1937, on a bid of $442,360. (Refer to Volume IV, Tabulation of Bids.)

Shop detailing and fabricating was executed for the contractor by the American Bridge Company at its Gary, Indiana, plant. Erection started at the terminal crossings of First and Fremont Streets on January 12, 1938. J. H. Pomeroy Company executed this work for the contractor.

Status of Work to Date

The contract is eighty-two per cent completed with only the catenary bridges remaining to be erected.

Personnel

Ambrose Diehl is president of the Columbia Steel Company; J. R. Fox is contract manager.

Mechanical Work (Contract No. R-2C)

This contract provides for heating, station and garage ventilating, drainage and sanitary installation required in the terminal.

The work was awarded to the Scott Company of San Francisco July 16, 1937, on a bid of $109,257. (Refer to Volume IV, Tabulation of Bids.)

Operations under this contract were, of necessity, controlled by the progress of general construction. Actual work started September 9, 1937, when pipes for center unit basement drainage were placed. Since that date work has kept pace with the progress of the project as a whole.

Status of Work to Date

As of June 30, 1938, all rough work has been completed with boilers and pumps, and ventilating fans and ducts in the center unit in place. The contract is estimated to be sixty-five per cent completed.

Personnel

William P. Scott, president of the Scott Company, is in direct charge of the project for the contractors.

Electrical Work (Contract No. R-2D)

Installation of the terminal's electrical power and lighting system is covered under this contract. The work also requires provision for train destination indicators, loud-speaker annunciators, telephone facilities and for services essential to operations of the other contractors.

Train Indicators

The contract was awarded to Radelfinger Brothers of San Francisco July 16, 1937, on a bid of $73,250. (Refer to Volume IV, Tabulation of Bids.)

Progress of operations under this contract is subject to general construction.

Status of Work to Date

Sufficient progress in general construction had been made by October 4, 1937, to permit installation of electrical conduits. Since that date work has progressed in coordination with the other terminal contracts. The contract as of June 30, 1938, is fifty-two per cent completed.

Personnel

S. M. Radelfinger and Fred Dresser are in charge of the project for the contractors.

San Francisco Viaduct

⟦Contract No. R-3⟧

Status of Work June 30, 1937

This contract was awarded to Eaton and Smith September 7, 1937, on a bid of $605,350. (Refer to Appendix A.)

General

The viaduct which provides the connection for the rails between the San Francisco-Oakland Bay Bridge and the terminal consists of earth embankment to Harrison Street, a reinforced concrete rigid frame over Harrison Street and earth embankment for half of the block between Harrison and Folsom Streets.

Loop Described

From this point, a concrete viaduct extends to a "Y" north of Folsom Street where it divides to start the terminal loop. The east portion of the loop continues beside the vehicular "off" ramp on Clementina Street and extends across First and Fremont Streets to Beale Street where it turns through 180 degrees to the east end of the terminal. From the west end of the building the loop is completed by a concrete structure returning to the "Y."

In general, the viaduct consists of reinforced concrete three-span continuous girders expanding either on split columns or bronze plates with the following exceptions:

Street Crossings

The Harrison Street crossing is a solid, reinforced concrete rigid frame built on a skew with an eighty-foot main span and thirty-six foot side spans. The Folsom Street crossing is also of the rigid frame design but in this case the design calls for girders and floor beams to support the slab. This crossing has an eighty-seven foot main span and forty-three foot side spans. Slabs on the remaining main street crossings and in the section of the viaduct east of Beale Street are carried on steel members. (Refer to Contract R-2B, page 23.)

Viaduct Deck

The deck of the viaduct consists of a concrete slab, paralleled on each side by curb and sidewalk, and further protected by a pipe railing. The slab varies in width in accordance with the number of tracks to be carried. The two tracks carried on the Bridge are to be increased to three as it leaves the span on the embankment. A fourth track will be added across the Folsom Street crossing to the "Y" where the tracks will branch in pairs to form the loop.

On the east section of the loop the two tracks will fan out to three, four, five and six tracks as they approach the terminal.

Leaving the terminal on the west loop the six tracks will be constricted into two as they go south to complete the loop at the "Y."

Foundations

The rock formation of Rincon Hill in the area bounded by Folsom, Fremont, Bryant and Second Streets provides excellent foundation material. As the slopes of the hill approach the lower elevations, depth to bedrock becomes increasingly great but a firm foundation of compacted sand was found overlying the rock except for a section in the east loop east of Fremont Street, where the old shore line of San Francisco Bay was at one time located. Here piles were used to support the structure.

Construction

Four concrete test piles were first driven and lengths of the required concrete piles determined. Piles were sixteen inches square and varied from thirty to forty-five feet in length. The concrete piles were driven in the section extending from Fremont Street to the second bent on the east side of the south Beale Street crossing. Beyond this point footings are below the permanent ground water line and untreated timber piles were used for foundations of the remainder of the east loop.

Concrete Pile Foundations

The viaduct structure fitted into a construction program whereby forms and falsework could be reused on groups of similar spans. For this reason work on the project was somewhat sporadic, and did not follow along a consecutive line of construction.

Because of the multiplicity of similar structures, the contractor chose to build the forms in his plant and assemble them at the site. Five-eighths inch, five-ply plywood, cemented with waterproof glue was used as form lumber above the footings.

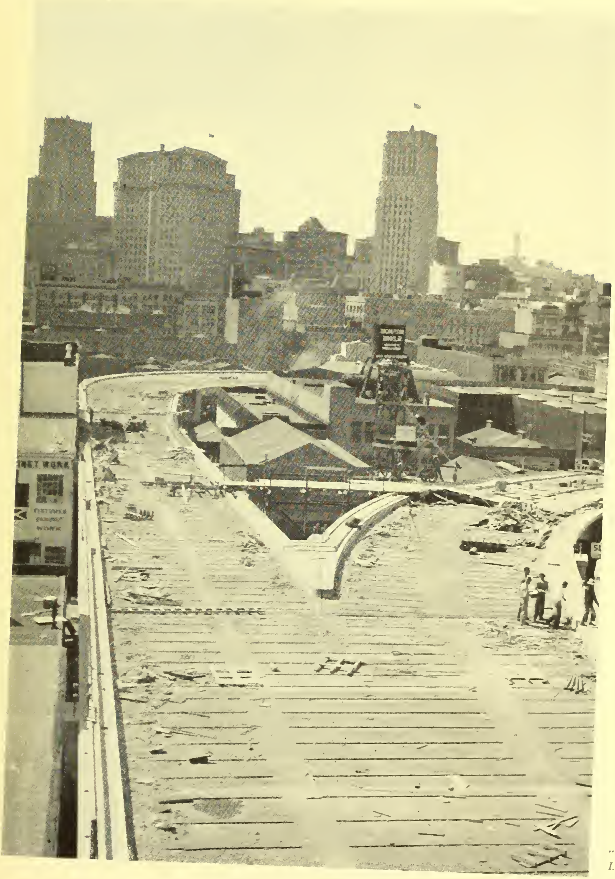
Status of Work to Date

As of June 30, 1938, work on the viaduct is eighty per cent completed, with grading work practically finished.

Personnel

H. C. Snead is manager and engineer; George T. Warren, superintendent; and Joseph E. Armstrong, resident engineer for the contractors.

N. W. Reese is resident engineer for the State.



"Y" San Francisco Loop, June 30, 1938

Substructures—East Bay Yard

⟦Contract No. R-4⟧

Status of Work June 30, 1937

Two units of this contract had been under way for several weeks prior to the close of the last fiscal year. Each was at that time approximately five per cent completed. These units comprise the footings for the catenary bridges in the yard, work on which began May 12, 1937, and foundations for the Port of Oakland overhead, which were started April 5, 1937. (Refer to Volume IV.)

Port of Oakland Overhead

GENERAL

Traffic originating in the outer harbor area of the Port of Oakland could reach the Bridge only over circuitous routes by way of Seventh or Fourteenth Streets to Peralta and thence north to the distribution structure. It was obvious that the interests of the Bridge and the Port would be better served by a more direct route.

Property Settlement

The property on which the East Bay yard is situated was under franchise to the Key System until 1960, after which it would revert to the City of Oakland. As one of the considerations in obtaining the city's title to this area, the State agreed to build the structural portion of a direct route to the outer harbor. On the other hand, the Port agreed to construct the extension of Maritime Street to provide the connection between the south end of the overhead and the harbor. This additional facility when completed will reduce the distance from the port area to the Bridge by about two miles.

SUBSTRUCTURE

The substructure for the overhead consists of ninety-seven reinforced concrete piers and foundations. These rest on untreated timber piles. Work was completed on December 3, 1937.

(Refer also to Superstructure, East Bay Yard, page 37.)

Catenary Footings

Throughout the East Bay yard depth to firm subsoil varies from 40 to 100 feet. It was necessary, therefore, to support all foundations for the catenary bridges and other structures on piles, varying in length from 50 to 110 feet. (Refer to Volume IV.)

Foundations were constructed of reinforced concrete resting on from two to five untreated piles at elevation +4. There are fourteen different types of footings totaling 335 structures.

Due to the necessity of synchronizing work with the change-over of Key System tracks from existing to new locations, it was found expedient to transfer the building of nine catenary footings to Contract R-21 for later construction. (Refer to page 47.)

Deck, Twenty-sixth Street Crossing, Looking West, May 4, 1938

With the exception of these foundations, work on this unit of the contract was completed April 11, 1938.

(Refer also to Superstructure, East Bay Yard, page 37, and Power Distribution, page 55.)

Southern Pacific Overhead

This structure is designed to carry the Interurban Electric westbound trains over Key System's eastbound tracks and the Oakland Terminal Railroad's freight tracks.

The substructure consists of thirty-five reinforced concrete piers and footings, all resting on untreated piles. Actual construction started shortly after the fiscal year began, and the contract was completed less than three months later.

(Refer also to Superstructure, East Bay Yard, page 38.)

Southern Pacific Twenty-sixth Street Overhead

Southern Pacific "Y" Described

In order to form a connection with the Bridge railway system and the Southern Pacific's existing interurban line, it was necessary to construct an overhead near Twenty-sixth Street, Oakland, in the form of a "Y." One leg turns north to connect with the Berkeley lines; the other south, connecting with lines to Oakland, Alameda and San Leandro. The structure also is designed to carry electric interurban lines over the Southern Pacific's main line tracks.

SUBSTRUCTURE

The overhead consists of 122 creosoted timber pile bents with a four-inch plank deck and sixteen reinforced concrete piers resting on untreated piles.

With the exception of that section of the structure within the Southern Pacific Company's main lines, all piles were driven with an eighty-foot skid derrick driver. Piles within the main line limits were driven by the company.

Construction of this unit was accomplished in approximately eleven months, with operations starting at the end of July of this fiscal year.

(Refer also to Superstructure, East Bay Yard, page 39.)

Personnel

This contract was held by Bates and Rogers Construction Corporation. F. L. Copeland, vice president, and R. Rasmussen, district manager, were in charge of the work.

Harry Carter was resident engineer for the State.

Summary

The contract was awarded March 19, 1937. Actual work started March 31, 1937, and was completed June 1, 1938.

QUANTITIES

East Bay Yard and Southern Pacific Crossing

Excavation	5,136 cubic yards
Creosoted timber piles, 40 ft. to 59 ft.	30,515 linear feet
Creosoted timber piles, 60 ft. to 79 ft.	26,539 linear feet
Creosoted timber piles, 80 ft. or over	568 linear feet
Untreated timber piles, 40 ft. to 54 ft.	14,848 linear feet
Untreated timber piles, 55 ft. to 69 ft.	10,519 linear feet
Untreated timber piles, 70 ft. to 84 ft.	23,224 linear feet
Untreated timber piles, 85 ft. or over	33,764 linear feet
Concrete in footings	3,438.91 cubic yards
Concrete above footings	1,485.00 cubic yards
Reinforcing steel	543,976.00 pounds
Anchor bolt material	91,922.00 pounds
Timber, creosoted	736.64 M fbm.
Hardware (timber)	54,000.00 pounds

Port of Oakland Overhead

Excavation	2,646.00 cubic yards
Untreated timber piles, 55 ft. to 69 ft.	8,582.00 linear feet
Untreated timber piles, 70 ft. to 84 ft.	29,556.00 linear feet
Untreated timber piles, 85 ft. or over	26,491.00 linear feet
Concrete in footings	1,901.04 cubic yards
Concrete above footings	1,671.60 cubic yards
Reinforcing steel	317,620.00 pounds
Anchor bolt material	30,058.00 pounds
Rock wall	70.00 cubic yards
Sand fill	6,507.00 cubic yards
Crusher run base	736.50 tons
Asphalt concrete	352.70 tons

COSTS

Total contract cost	$684,802.50
Less total extra work orders	164,419.60*
Total expenditure	$522,382.90

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* Foundations for inspection building transferred to Contract R-21A.

Signals and Interlocking

⟦Contract No. R-5⟧

The design of the railway facilities was based on the operation of ten-car trains on a minimum 63½-second headway, or approximately fifty-six trains per hour on each track. Such a density of traffic has never before been attempted and is made possible by using the latest developments in railway signaling. (Refer to Volume IV.)

Cab Signal System Required

The investigations, made in consultation with the engineers of the railroad companies and of leading signal companies, resulted in the decision to adopt a four-speed continuous cab-signal and train-control system. Provision in the agreements with the railroads required equipment on the cars to work in conjunction with that specified for the wayside installation.

Cab-Signal and Train-Control System

The installation provides an automatic block system with double-rail track circuits and requires the use of reactance or impedance bonds at the insulated joints to provide a path for the negative return of the power current. The occupancy of a block affects the controls of the blocks in its rear, but instead of the usual wayside signals, the 100-cycle signal current in the rails is uniformly interrupted, the rate of interruption in each block depending on its distance behind the occupied block. A clear track ahead is denoted by 180 interruptions per minute; occupancy less than "clear track" distance by 120 interruptions per minute; occupancy in the second block ahead by 75 per minute. Occupancy in the first block ahead or in the immediate block is denoted by a steady or by no current.

"Receivers" Described

Receivers at the front end of the train "pick up" the signal current by induction, filtering and amplifying it, and the interruption rate picks up the proper relay on the train, thereby selecting the cab-signal light and the set of governor contacts which will remain in control so long as that code continues to be picked up. The designed arrangement of codes and controls is as follows:

Code interruptions per minute	*Cab signal aspect*	*Authorized speed m.p.h.*	*Speed above which white light is lighted m.p.h.*	*Speed above which warning signal is sounding m.p.h.*	*Speed at which emergency brakes are automatically applied m.p.h.*
180	Green 35	35	35	36	37
120	Yellow and Green 25	25	25	26	27
75	Yellow 17	17	16½	17½	18½
None	Red 11	11	10¾	11¾	12¾

Cab Signal Cancellations

An additional code of 240 interruptions per minute, used at points where trains leave cab-signaled tracks, cancels the cab-signal and train-control equipment on the train, lights a violet light in the cab signal showing the letters "NS," and permits the train to proceed without speed restrictions until a control code is again encountered.

Connecting
Impedance Bonds,
April 12, 1938

Interlocking Plants

Two interlocking plants are required for the East Bay yard and San Francisco viaduct and terminal respectively.

Main Track Signals

In the East Bay yard the interlocking plant includes the main tracks, the eight set-out tracks, the connections and switches between such tracks, switches for entering or leaving these tracks, and all signals governing routes through these interlocked switches. There are thirty-six interlocked switches and sixty-two color-light signals of the searchlight type in this plant. Main-track signals for the normal direction of traffic are one or two-unit high signals. All others are single-unit dwarf signals. At the east bound divergence from joint track, the signal carries two white marker lights to indicate to the approaching train whether the switch is set for the Key System or the Southern Pacific connection. To give the approaching train the earliest possible warning, or assurance, as the case may be, the marker light is repeated at two preceding high signals.

In the San Francisco terminal loop, all switches and signals are interlocked. There are thirty-six switches and forty dwarf signals.

"No Code" Conditions

Cab-signal blocks with code in the normal direction of traffic are carried continuously through all interlocking territory. The wayside signals are therefore primarily route signals but are arranged to operate in a manner consistent with track conditions. A yellow clear indicates a "no code" condition in the immediate block; that is, the train must expect that, upon passing a yellow wayside signal, a "Red 11" cab signal will be received. With the normal control, a cleared signal will return to "stop" when the head of the train passes it.

Signals at entrances to cab-signal territory, such as those leading from storage tracks to set-out tracks in the East Bay yard, are known as "TC" signals. When a "TC" signal is cleared with the immediate block occupied, the aspect is a flashing yellow instead of steady yellow. With this aspect showing, the train is required to stop before passing the signal. The choice of clear aspect, whether green, steady yellow, or flashing yellow, is automatic and entirely dependent on track conditions and not at all dependent on the choice between normal and special control.

Interlocking circuits are so arranged that a signal may not be cleared unless all switches in the route governed are properly positioned. It is impossible to move any switch unless all signals governing operations through that switch are in stop position. If a signal is thrown to stop in the face of an approaching train, switches in the route will remain locked until a safe time interval has elapsed.

Signals In Stop Position

NX CONTROL MACHINES

The control machines to be installed at the two interlocking plants are the latest development in equipment for this purpose and are designed to provide the utmost facility for speed and precision of interlocking control. The various controls and indications are arranged directly on a track diagram so that memorizing of lever numbers and their related functions is not required.

Route Set-Up Described

To set up a route in the interlocking plant; that is, to position properly the switch or switches and clear the signals, it is only necessary to push the initiation button at the entrance to the route and then push the completion button at the exit from the route. As soon as the switches have operated to their proper positions, the signals will clear. The train passes through, restoring the signal to stop and releasing each switch as it passes out of its block.

A series of adjacent routes may be operated as one, this being known as end-to-end operation. It is only necessary to press the initiation button of the first route and the exit button of the last route and all intervening switches will properly position and intermediate signals will clear, as well as the initial signal. In many instances of end-to-end operation, more than one route exists between the two points. The preferred route will be automatically selected and set up if it is available. If for any reason it is not available, the machine will automatically select and set up the optional route. One end-to-end location in San Francisco has four possible routes which are automatically selected as available in their prescribed order of preference.

When initiating a route, the initiating button may be operated in either of two ways. It may be pushed or it may be rotated ninety degrees. If the route were set up by pushing the initiating button, any occupancy of the block immediately beyond the signal will return the signal to stop; therefore, the route may not be set up by this means if this immediate block is occupied. If the route were set up by rotating the initiating button, occupancy of the immediate block will not return the signal to stop and the route will remain set up for any following train or trains. A route that is set up may be canceled by pulling the initiating button if it had been pushed, or by rotating it back to the normal position if it had been rotated.

Terminal "Go" Signals

On the San Francisco control board, in addition to the usual indications of signals, switches and occupancy, a green light is provided on each of the six lines representing the six tracks in the train shed. When a train is ready to leave, the conductor presses a button on the platform. The corresponding green light on the board is lighted and remains lighted until the signal authorizing the train to leave the shed is cleared.

TRAIN-DESCRIBER EQUIPMENT

On each control machine there is a special group of buttons and lights which constitutes the visible control of the train-describer equipment. These buttons and

Placing Cable in "Bungalow" June 14, 1938

Train Identities

lights are lettered and numbered in accordance with the established identities of the various trains. When a train is given its outgoing route from the San Francisco plant, the operation is the usual pushing of the entrance and the exit buttons. But in this case, instead of operating the regular exit button, the control-board operator is required to press one of this special group, thus setting up the identity of the outgoing train, as well as setting up and clearing the route. When the train accepts the signal, its identity is transmitted to the Oakland control machine where it is eventually displayed in the group of lights on that board.

Train identities to the number of fifteen are transmitted in either direction over a single pair of wires by means of variations in the polarities of four successive direct current impulses.

SIGNAL TOWERS

East Bay Signal Control Board

The East Bay interlocking machine is housed in a three-story reinforced concrete building, fourteen by thirty feet in plan, built exclusively for that purpose. (Refer to contract R-21A, page 49.) The machine occupies the third floor; the relay room, the second floor; and the battery room, the first floor.

San Francisco Control Board

The San Francisco machine is located on an elevated ten by twenty-three-foot platform above the track level in the southwest corner of the Terminal Building. The relay room, fourteen by twenty-nine feet, is in the west mezzanine. Two battery rooms, one fourteen by twenty-nine feet on the first floor at the west end of the building, and one fourteen by twenty-three feet in the east basement, are provided.

Progress of Work

The contractor established his field headquarters in the East Bay yard on February 14, 1938, since which date the signal work has followed the track work as closely as possible.

The fourteen-month interval between the date of award and the beginning of work in the field was used by the contractor to complete the detail engineering and to manufacture the large quantities of special equipment.

Interlocking Equipment Installed

Actual installation of interlocking equipment was inaugurated in the East Bay yard on February 28, 1938, when three switch machines were placed. With the exception of a few minor items, installation of equipment in the yard is now complete, all cables are placed and connected, and only the relay room connections in the tower and the testing throughout the yard remain to be done before the interlocking plant is placed in temporary service.

The State has purchased two 100-cycle, motor generator sets which will be installed in the new mole substation when it is completed. One set will provide signal power for the entire bridge railway and the other will serve as a standby. One set has been temporarily installed adjacent to the Oakland Signal Tower and is available for testing purposes and for temporary operation of the plant during the construction period.

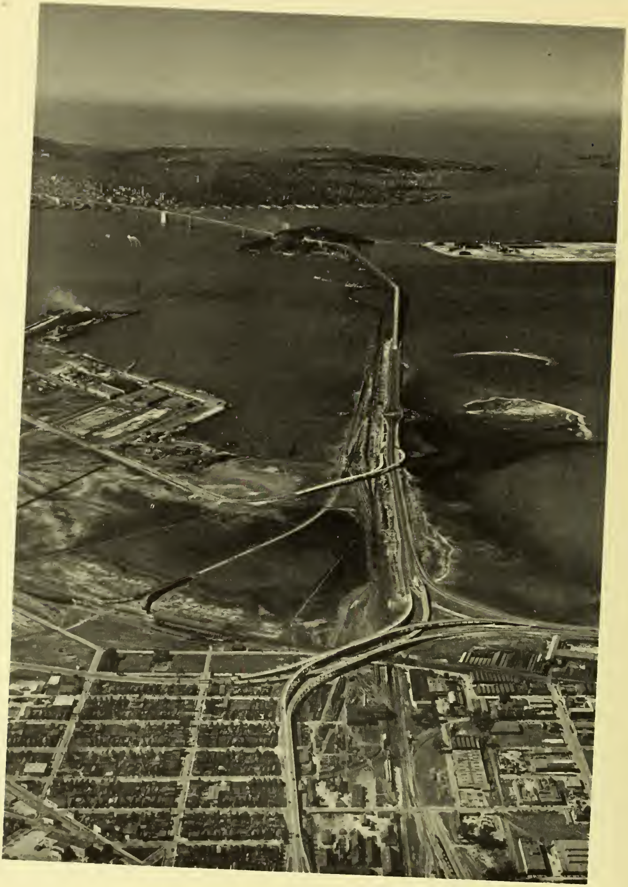
The placing of signal cable on the bridge was started at the east end of the structure on June 16, 1938. To date, power and instrument cases, impedance bonds, and cable have been placed westward as far as the Yerba Buena anchorage.

As of June 30, 1938, the contract is forty-nine per cent completed.

Personnel

This contract is held by the General Railway Signal Company of Rochester, New York. Paul Renshaw is president of the company. A. C. Holden is resident manager, and E. W. Stone, resident engineer in direct charge of the work for the contractors.

C. R. Davis is resident engineer for the State.



Aerial View, Looking West, East Bay Yard, Showing Twenty-Sixth Street and Port of Oakland Overheads, March 24, 1938

Superstructure—East Bay Yard

⟦Contract No. R-7⟧

General

This contract comprises the superstructure for the catenary bridges, Port of Oakland overhead, Southern Pacific overhead, and a portion of the Southern Pacific Twenty-sixth Street overhead. The work was awarded to J. H. Pomeroy Company of San Francisco April 6, 1937, on a bid of $536,960. (Refer to Tabulation of Bids, Volume IV.)

Catenary Bridges

Steel catenary bridges were constructed at intervals of approximately 200 feet over the entire yard. Erection of steel was started in November of the last fiscal year and work was completed less than five months later.

There were a total of fifty-one catenary bridges and forty-four steel poles erected under this contract.

Catenary Bridges Painted

While the contractor elected to paint a portion of the steel in his plant, the major part of the work was executed in the field. Final coat was aluminum to harmonize with the Bridge. This work was completed May 24, 1938. (Refer also to Substructure, East Bay yard, page 28 and Power Distribution, page 55.)

Port of Oakland Overhead

Port Overhead Design Described

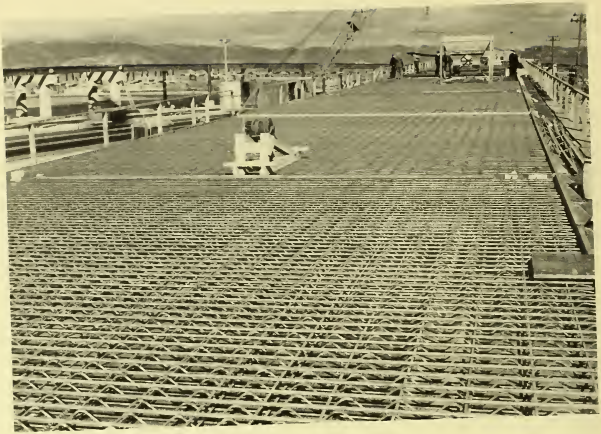
From its south end, the Port of Oakland overhead rises on a four per cent grade and crosses all tracks at the east end of the yard. Near the north side of the yard the roadway branches, in order that traffic from the Port need not cross the main Bridge highway approach at grade. One leg crosses the highway for "On" Bridge traffic. The other leg, for "Off" Bridge traffic, comes to grade at the south side of the highway.

South of the "Y" formed by these branching roads, the roadway is forty-four feet between curbs, and provides for four traffic lanes. Each branch is twenty-two feet between curbs, providing for two one-way traffic lanes.

The structure has forty-two steel spans of an average length of forty feet. On the wider portion of the structure, seven twenty-seven-inch wide flange girders spaced six feet ten and one-half inches support a seven-inch reinforced concrete paving slab. For the narrower twenty-two-foot roadways, four twenty-seven-inch wide flange beams support a similar paving slab. Hand-rails consist of two lines of four-inch pipe supported by eight-inch pipe posts at seven-foot centers.

At the north end of the roadway crossing the Bridge approach, the subsoil was not sufficiently stable to withstand the weight of an earth fill approach; therefore ten fourteen-foot spans of timber trestle with concrete paving were constructed.

Work on the superstructure for this project was started September 20, 1937, and was completed March 7, 1938. (Refer also to Substructure, East Bay yard, page 28.)



Reinforcing Bars, Port of Oakland Overhead, November 24, 1937

Southern Pacific Overhead

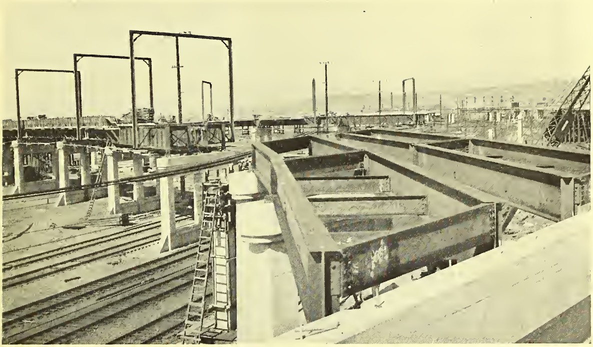
This structure is a grade separation carrying interurban electric westbound trains over the Key System and Oakland terminal tracks.

It is an open deck steel trestle, 1155 feet in length, consisting of twenty-eight forty-one-foot three-inch spans and two eighteen-foot braced bents.

Each end is on a four per cent grade, joined by a vertical curve across the center of the structure. The girders consist of thirty-three-inch wide flange beams, one per rail, and are supported by steel bents extending to the top of the concrete pedestals.

Actual construction started October 5, 1937, and was completed March 29, 1938. All sandblasting and painting was accomplished in the field after erection. Final field coat was of aluminum.

Port of Oakland Overhead, February 21, 1938



Twenty-Sixth Street Crossing Over Southern Pacific Main Line, February 4, 1938

Twenty-sixth Street Overhead

Work on the superstructure of this project involved the erection of fourteen steel girder spans and the placing of concrete decks and pipe railing over the Southern Pacific main line tracks. Each span averaged sixty feet in length. Maximum length was seventy-six feet.

Construction started January 26, 1938. Work was completed June 7, 1938. (Refer also to Substructure, East Bay yard, page 29.)

Summary

Contract was awarded April 6, 1937, and work has been completed, except for minor items, as of June 30, 1938.

QUANTITIES

East Bay Yard and Southern Pacific Crossing

Structural steel, overheads	1,284,480.00 pounds
Structural steel, catenaries	1,156,982.00 pounds
Concrete	746.70 cubic yards
Reinforcing steel	110,083.00 pounds
Cast steel shoes	18,204.00 pounds
Pipe railing	11,465.00 pounds
Timber	5.89 M fbm
Painting, Twenty-sixth Street crossing	422.90 tons
Painting, Southern Pacific overhead	228.45 tons
Painting, catenaries	578.49 tons
Extra Portland cement	92.56 barrels

Port of Oakland Overhead

Structural steel	1,810,989.00 pounds
Concrete	2,199.55 cubic yards
Reinforcing steel	134,917.00 pounds
Reinforcing trusses	170,842.11 linear feet
Pipe railing	189,667.00 pounds
Painting	905.50 tons
Extra Portland cement	267.69 barrels

COSTS

Total contract cost	$536,960.00
Total extra work orders	–7,544.74*
Total expenditure	$529,415.26

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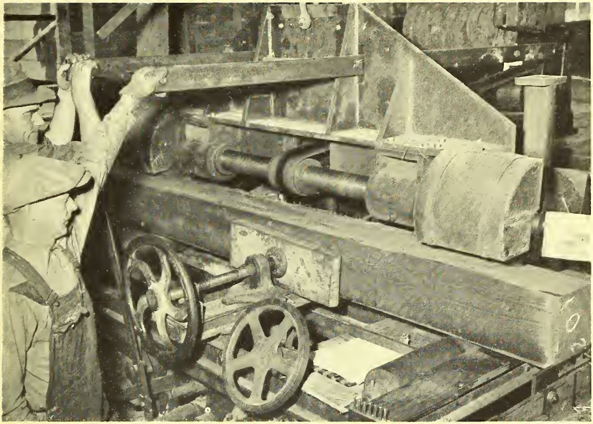
* Decrease in quantities below engineer's estimate.

Personnel

Philip Gutleben was in charge of the work for the contractors.

Harry Carter was resident engineer for the State.



Dapping Machine for Bridge Ties

Track Work, Bridge and San Francisco Loop

⟦Contract No. R-9⟧

General

This contract comprises the construction of double tracks and a third rail system on the bridge from Pier E-23 at the easterly end of the structure to and including the San Francisco viaduct and terminal where the rails diverge into six tracks. Total length of the tracks involved under the contract is equivalent to thirteen and one-half miles of single track.

Materials Supplied By State

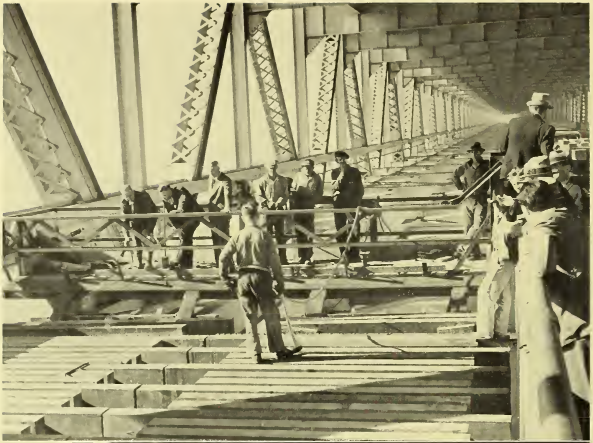
Materials provided by the State for this contract include: all ties, lumber, galvanized hardware, rails and fittings, tie plates, track spikes, contact rail and appurtenances and special trackwork. (Refer to Volume IV.) The contractor is furnishing structural steel for signal case platforms, expansion device grillage and catenary expansion joints; paint for the steel and crushed rock ballast.

Description of Work

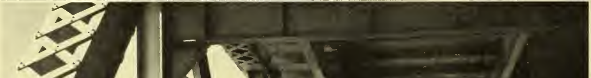
Weight restrictions required an open-deck track construction on the bridge. The Yerba Buena Island crossing and the San Francisco loop (including viaduct and terminal) are of ballasted construction.

Bridge Rail Ties

Ties for the bridge are of redwood, averaging eight inches by nine inches, spaced on twelve inch centers. They are dapped at the contractor's yard by a special machine having a double cutter-head. After dapping, the ties are delivered by a



Placing First Tie on the Bridge, November 30, 1937



Bridge Trackwork Progress, February 12, 1938 lumber carrier to the proper site and placed in the position charted for them by means of a moving gantry running on the stringers.

Long ties, at three-foot spacing, carry planking sidewalks between and at either side of the tracks. Where the track passes over streets or inhabited areas, the walkway covers the entire roadbed. Except at expansion joints, four-inch by eighteen-inch beveled spacer blocks are placed between the ties to prevent bunching.

Bridge Track Rails Described

Track rails are ninety-pound A.R.A. section. Relayer ninety-pound rail is used for the guard rail. Two five-by-eight timber guard rails per track are also used. The track is secured to the steelwork by two three-quarters-inch hook bolts per track in every third tie. The timber guard rail is prebored for boat spikes which are also employed to secure the track to the ties.

Materials are hauled to the site by trucks and placed by means of a truck crane. Pneumatic tools are used for bolting and spiking the rails in place.

Derailment Protection

In this trackwork, there are two departures from standard construction. First, the large movements at the expansion joints are considerably greater than on any other structure. Hence provision for railway tracks required a new design of rail expansion joints. Second, a new design of flangeway guard rail was developed to insure against derailment on the twenty-degree curves in the San Francisco loop.

EXPANSION JOINTS

Since the movements at the towers of the suspension span of the west crossing were the most complicated, these movements controlled the design. At these points, in addition to the usual longitudinal motion, there is vertical motion produced by the link connections of the suspended trusses to the towers, a change in the grade line arising from the vertical deflections of the spans, and a pivoting horizontal action arising from the deflection of the spans under lateral forces.

This combination requires the joints to be universal in their action. The greatest longitudinal motion occurs at Tower W-2 where the side and center spans each have a total motion of thirty inches in one direction, or a total of sixty inches.

Expansion at each side of the tower is taken at two points in order to cut the amount of expansion at any one point to a minimum. The result is a maximum motion of seven and one-half inches in each direction at any point.

This division of motion is obtained by an equalizing lever. A continuous gauge is obtained by a point rail sliding through guides.

Protection against derailment is secured by guard rails which are fastened to the supporting base plate and clamped to the running rail by "U" clamps.

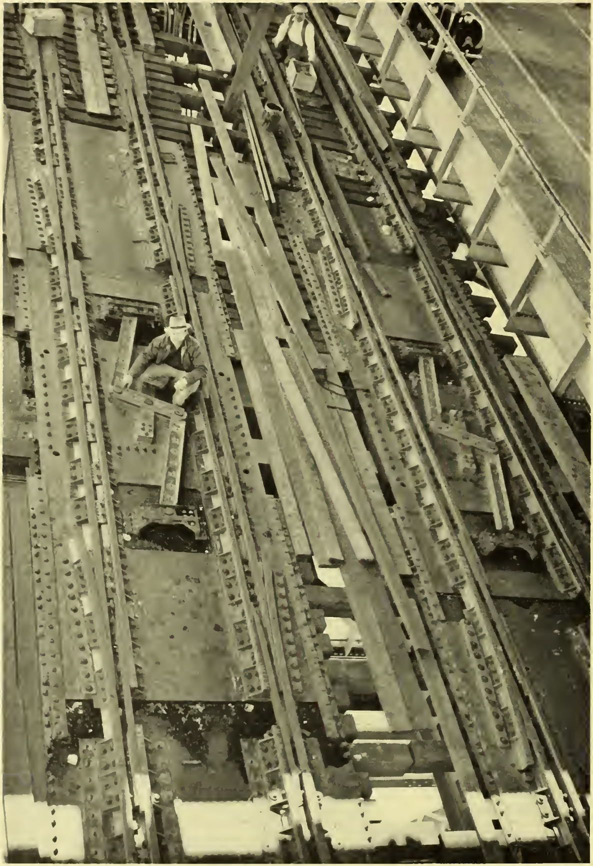
Electrical Insulation

In order to secure proper signal protection, it was required that each rail be insulated from the others. To keep the negative propulsion current from the bridge, complete insulation from the bridge steel was necessary. Electrical insulation is secured by the use of micarta between the steel plates and the bridge steel with thimbles of the same material around all the connecting bolts. (Refer also to "Power Distribution," page 56.)

A total of twenty-two expansion devices are required for the Bridge crossing.

FLANGEWAY GUARD RAIL

At the ends of railroad terminals, there is usually a complicated layout of switches so that trains may be routed to any station track. In the San Francisco loop,



Rail Expansion Joint,
June 17, 1938

this complication will be increased by reason of the sharp curves at either end. Also, as a precaution against derailment in these sharp curves, a safety guard rail will be placed adjacent to the low or inside rail. This member will consist of 110-pound rail which is five-eighths-inch higher than the ninety-pound rail and is so placed with relation to the track rail as to provide a flangeway of one and five-eighths inches.

Curved Switches

Among the items of special track work in this area, there is a total of forty switches, most of them curved, and a corresponding number of frogs.

All rail and guard rail was bent and drilled for connections in the shop in order to secure the best possible alignment.

CONTACT RAIL

The contact rail system requires 150-pound and 55-pound rail. Rails are supported on porcelain insulators held on metallic cups which are fastened to the long ties. The 150-pound contact rail will be used throughout the bridge except for short runs adjacent to crossovers. (Refer also to Power Distribution, page 57.)

In the San Francisco loop, 150-pound rail will be used on main tracks except in the terminal, where 55-pound contact rail will be installed. The lighter rail will also be used for crossovers.

End Approaches for Contact Shoe

The contact rail will be provided with end approaches insuring smooth operation for the contact shoe. Side approaches and folding ramps will be provided to facilitate operation of the shoes at crossovers and diverging tracks.

Protection Boards

Redwood timber protection boards will be installed for the contact rail. The top cover-board is one and three-quarters by seven and one-half inches and one and one-quarter inches by eight and seven-eighths inches. Side boards are seven-eighths inches by six inches. The protection boards will be framed to galvanized brackets and attached by lag screws to the long ties in eighteen-foot lengths.

Progress and Status of Work

The contract was awarded to the Pacific Bridge Company September 22, 1937, on a bid of $469,236.50. Work started October 26, 1937, and by the end of the fiscal year the contract had progressed as follows:

Structural steel	50%
Painting structural steel	70%
Framing and placing bridge ties	91%
Framing and placing spacing blocks	91%
Framing and placing timber guard rails	90%
Framing and placing walkways	90%
Ballast	7%
Laying double track bridge crossing	90%
Track laying, San Francisco loop	0%
Contact rail and protection board, bridge and San Francisco loop	14%

Personnel

Philip Hart is president of the Pacific Bridge Company; J. A. Ginella is superintendent.

Expansion joints on the bridge and the special trackwork in the loop, including the bending of the rail, were fabricated by the Ramapo Ajax Division of the American Brake Shoe and Foundry Company under the supervision of W. P. Janicki.

Harry Carter is resident engineer for the State.

East Bay Yard—Key System Work

[[Contract No. R-21]]

General

Storage Yard Area Described

Storage space was required for interurban trains operating over the bridge rail system and also for inspection buildings. The obvious location for these facilities was in the area occupied in part by the existing Key System mole at the easterly end of the Bridge. Title to this property was accordingly acquired.

The area involved in the transaction will provide for the storage of 123 Interurban Electric cars; 90 Key System articulated units; 15 Sacramento Northern cars; and three inspection buildings; and other smaller structures including the signal tower.

The existing Key System tracks ran through the center of this area. It was necessary to keep the Key System in operation during the installation of the new facilities and this condition has controlled the sequence of construction. It was also required that the Oakland Terminal Railroad, a Key System subsidiary, be relocated.

Construction

Imported Fill

The area occupied by the Yard was only partially reclaimed. The first operation, therefore, was to fill the low areas. This work was done by Key System forces. A total of 309,968 tons of sand and gravel was imported for this purpose. The fill was protected by a riprap wall along its south shore side, requiring 7651 tons of material.

Temporary Track Construction

Incidental work on the existing Key Mole consisted of temporary track construction to facilitate fill operations; construction of piers in the yard; and removal and relocation of those feeder lines and sections of the overhead system that interfered with foundation and superstructure projects executed under Contracts R-4 and R-7.

Fill material was delivered in railroad gondola cars, placed by means of two cubic yard clamshell crawler cranes and spread by bulldozers. Trucks and carry-all scrapers distributed the material. (Refer to "Materials," Volume IV.)

Status of Work June 30, 1938

Work on the fill and shore protection for the Yard has been completed. Incidental construction operations involved under the contract are ninety-five per cent completed.

Personnel

S. G. Culver, chief engineer for the Key System, is in charge of the work for the company.

Harry Carter is resident engineer for the State, and for all contracts involving East Bay projects for Bridge rail facilities.

East Bay Yard—Track Work

[[Contract No. R-21A]]

Description

Construction of all tracks between Pier E-23 on the bridge and connections with the existing Key System tracks at the east end of the yard and existing Southern Pacific tracks on the Twenty-sixth Street overhead is included in this contract, except for installation of temporary tracks noted under Contract R-21. (Page 47.)

Total Trackage Eighteen Miles

The Yard track system includes Bridge main line tracks, storage tracks, contact rail and protection board. Total length of tracks under this project is equivalent to eighteen miles of single track, of which six and one-half miles are of new ninety-pound A.R.A. track and eleven and one-half miles are of relayer ninety-pound track. All switches and special work were new. Sawed redwood ties were used for main and set-out tracks; split redwood ties for storage tracks.

Also involved under the contract are construction of the Yard drainage system, certain concrete structures, and the timber open-deck for the Southern Pacific overhead. The project in addition required some excavation and the placing of imported fill other than that noted under Contract R-21. (Refer to page 47.)

Construction

Main line, set-out and portions of the storage tracks were placed on the north and south sides of the existing Key System tracks which were in continuous service.

Outside main line tracks were first placed and permanent connections made to the Key System tracks at the east end of the Yard. Set-out tracks were next laid and storage tracks then extended toward the existing Key Sysem tracks.

It was necessary to raise the north part of the Yard, which was a portion of the old Key fill, to the required subgrade. This area was prepared for track operations by means of motor grader and rollers.

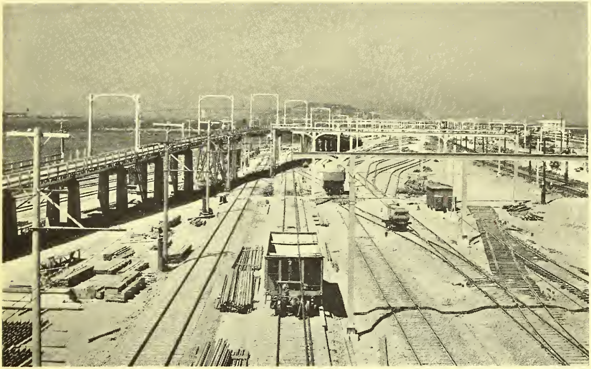
Rock Ballast

The subcourse of crushed rock ballast was delivered to the site on barges. Trucks distributed and spread the material using spreader boxes. The ballast was then thoroughly compacted by an eight-ton roller. The finished ballast course is delivered and spread from railroad ballast cars. Pneumatic tools are used for tamping this course.

Track materials are distributed by trucks or railroad cars, depending on accessibility to the tracks under construction. All ties are prebored for the track spikes. Pneumatic tools are used for bolting and spiking purposes.

Insulators for Contact Rail

The contact rail system in the Yard, as on the Bridge (refer to page 45), comprises 150-pound and 55-pound rail supported on porcelain insulators held on metal cups and fastened to long ties. Supports are on approximately twelve-foot centers. Eighty-three per cent of the contact rail in the yard is 150-pound and the remainder 55-pound rail. Folding ramps, that lower the train shoe on to the rail or fold it up when not in use, are placed at points in the yard where the train approaches or leaves the contact rail system.



East Bay Yard, Looking West, June 30, 1938

Contact Rail Protection Boards

Contact rail protection boards are of redwood. The top cover board is one and three-quarters inches by seven and one-half inches and one and one-quarter inches by eight and seven-eighths inches. Side boards are seven-eighths of an inch by six and seven-eighths of an inch by eight inches. The protection board is painted and framed to galvanized brackets at the contractor's yard in approximately eighteen-foot sections.

Yard Ties

Ties for the open-deck timber construction on the Southern Pacific overhead were dapped with a special machine with one cutter-head. Ties are spaced on the structure at approximately one-foot centers. On the fixed spans the ties are blocked by four-inch by eighteen-inch timbers with beveled tops.

Long ties are placed for every third tie and these carry the walkway and handrail. Ties are fastened to the structure by hook-bolts under the stringer flange and pass through the tie and a five-inch by eight-inch timber guard rail. Boat spikes, one-half inch by nine inches, fasten the guard rail to the remaining ties.

Signal Tower Foundations

The contract also includes construction of foundations of Yard inspection buildings; signal tower (refer to "Signal and Interlocking," page 34); and the Yard and east end tie stations (refer to "Power Distribution," page 56). Other work involved under this contract comprises erection of concrete signal case foundations; a protection wall between the rail section and the truck exit at the easterly end of the lower deck of the bridge; car-washing platforms; and curbing; and placing of asphalt-surfaced walkways and road to the inspection buildings and passenger platforms.

Yard Drainage

A complete system of yard drainage will be constructed. Cast iron mains will be used for drainage from the inspection buildings and perforated corrugated metal pipe laterals will be installed between the tracks. Mains not servicing the buildings are corregated metal pipe.

Materials Furnished By State

Materials furnished by the State under this contract include all ties, lumber, galvanized hardware, rails and fittings, track spikes, contact rail and appurtenances, and special trackwork. All other materials are provided by the contractor.

Status of Work to June 30, 1938

Bates and Rogers Construction Corporation were awarded the contract September 21, 1937, on a bid of $428,363.75. Work started October 26, 1937. To date the work stands as follows:

Flange protection of steelwork	100%
Framing and placing bridge ties	50%
Framing and placing other floor timbers	16%
Excavation	25%
Imported fill	99%
Prepare subgrade	70%
Yard drainage	85%
Ballast	44%
Track laying	50%
Contact rail and protection	20%
Concrete	35%

Personnel

F. L. Copeland, vice president of Bates and Rogers Construction Corporation, and R. Rasmussen, district manager, are in charge for the contractors.

Harry Carter is resident engineer for the State.

Southern Pacific Connections

⟦Contract No. R-22⟧

Description

This contract involves realignment of Southern Pacific main line tracks made necessary by the construction of foundations for the Twenty-sixth Street overhead; connection of the existing interurban lines to the Bridge system; and rearrangement of existing signals and overhead system. The Bridge railway signal system terminates at the overhead "Y" of the Oakland and Berkeley branches. All signals east of this point are controlled by the Southern Pacific Sixteenth Street tower.

Terminus of Bridge Signal System

The project also includes the construction of tracks, signals and catenary on the Twenty-sixth Street overhead.

Status of Work June 30, 1938

This work is being executed by Southern Pacific Company forces. The project was started at the close of the last fiscal year. To date all changes to existing tracks have been made except for connections with the Bridge system on the Twenty-sixth Street overhead. Signal work, including installation of new equipment and rearrangement of the existing system, is seventy per cent completed. Work on the existing overhead facilities is eighty per cent completed.

Personnel

B. J. Hogan, assistant division engineer of the Southern Pacific Company, is in direct charge of this work.

Harry Carter is resident engineer for the State and for the other related contracts following.

Southern Pacific-Santa Fe Interchange Yard

⟦Contract No. R-23⟧

General

The design of the Southern Pacific Twenty-sixth Street overhead placed the Oakland branch of the "Y" in an area at Thirty-fourth and Wood streets, occupied by a Southern Pacific-Santa Fe freight interchange yard. It was therefore necessary to relocate these tracks so as to clear the new construction. This was accomplished by Santa Fe forces.

Seventh Street and Alameda Connections

⟦Contract No. R-24⟧

The routing of Oakland and Alameda Southern Pacific interurban trains over the Bridge rather than to Oakland and Alameda moles respectively, required new connections at Seventh and Bay streets, Oakland, and at Lincoln Junction, Alameda.

The work under this project is being performed by Southern Pacific forces under an agreement and provides for track, catenary, and signal installations and changes.

Status of Work June 30, 1938

Surveys

Surveys for the work have been made and plans prepared and approved. Grading for the Lincoln Avenue and Seventh and Bay streets connections has been completed except in street areas.

Personnel

B. J. Hogan, assistant division engineer of the Southern Pacific, is in charge of this work for the company.

Power Distribution System

⟦Contracts Nos. R-10; R-21C; R-11; R-21B⟧

General

For purposes of coordination, the contracts involving the distribution of power to the Bridge rail system are grouped under this chapter. Included in this discussion is a description of the substations, which although not constructed or financed by the State, are necessarily an inseparable part of the Bridge rail power system.

Contracts described are R-10, catenary and feeder system, Bridge and San Francisco loop; R-21C, catenary and feeder system, East Bay yard; R-11, bonding, Bridge and San Francisco loop; R-21B, bonding, East Bay yard.

Description

The power distribution system required more investigation than any other question connected with the Bridge railway. The Southern Pacific operates at 1300 volts, the Key System at 625 volts. Estimates of the power distribution system, including the substations and the necessary changes to equipment as affected by the voltage, were made on the following bases:

Volt Systems

1. *625-Volt System.* This would have required "change-over" equipment on the Southern Pacific motor cars, enabling full speed on 625 volts.

2. *1300-Volt System.* This would have required entirely new motors for the Key System and "change-over" equipment to operate on 625 volts in their East Bay territory.

3. *Dual-Voltage System.* On tracks over which both Key and Southern Pacific operate, the Key will take power from the third rail at 625 volts and the Southern Pacific power from catenary at 1300 volts. On tracks on which Key System trains only are operated, the Key will take power from 625-volt catenary.

The Sacramento Northern cars are so wired that they can operate on either 625 or 1300 volts.

On the basis of estimated cost, there was little to choose between the three plans; however, the Southern Pacific was unwilling to adopt the 625-volt plant and the Key System was equally averse to adopting 1300 volts, so the dual-voltage plan was adopted.

Dual Voltage Plan Adopted

The design of the substations and distribution system was based on the peak load corresponding to 35,000,000 passengers annually. Calculations based on this assumption and the physical conditions involved gave the maximum currents as follows:

Maximum Currents

Maximum—1¼ Minutes

Substation	*625-volt*	*1300-volt*
Sterling	9700 amperes	5300 amperes
Island	8200 amperes	
Mole	7500 amperes	4000 amperes

	Average Maximum—30 Minutes	
Sterling	6400 amperes	3500 amperes
Island	5300 amperes	
Mole	4800 amperes	2570 amperes

Substations

Three substations, one at Sterling Street on Rincon Hill, San Francisco; the second on Yerba Buena Island, east of the tunnel; and the third at the west end of the East Bay yard are designated respectively as the Sterling, Island, and Mole substations. The Sterling and Mole substations are being built on property belonging to the State, and the Island substation is within the right of way lines of the "joint permit" from the United States Government to the State. They are being built and financed by the Pacific Gas and Electric Company and sold to the railroads on an installment basis.

At the Sterling and Mole substations, energy is converted from 11,000 volts, a.c. to 1300 volts d.c. for the Southern Pacific, and 625 volts d.c. for the Key System. Only 625 volts d.c., for Key System use, is produced at the Island substation. The installed capacity in these substations is as follows:

pacity of Substations

	625 volts	*1300 volts*	
Sterling	2—2000 kilowatts	2—2500 kilowatts	
Island	2—2000 kilowatts		
Mole	2—1000 kilowatts	2—2500 kilowatts	
	1—1500 kilowatts		
	11,500 kilowatts	10,000 kilowatts	
TOTAL			21,500 kilowatts

onversion Equipment

The conversion equipment consists of mercury arc rectifiers with the exception of the 1500-kilowatt unit in the Mole substation, which unit is an existing motor generator set. In addition to the converters, there is the corresponding installation of transformers and switchgear.

In addition to the above installation, the 1300-volt supply in the East Bay yard may be supplied from the Southern Pacific East Oakland station, and the east end of the same yard will be fed with 625-volt energy from the Key Yerba Buena station in Emeryville.

The distribution system was designed, on the basis of the loads above given, so that the drop, including the negative return, would not exceed 75 volts in the 625-volt system and 200 volts in the 1300-volt system. In general, the design was such as to avoid feeders, all of the required conductivity being built into the catenary and third rail systems, respectively.

Catenary

Catenary Quantities

The standard catenary system used on main tracks consists of one 500,000-c.m. main and one 4/0 intermediate messenger of H.D. copper and two 4/0 contact wires of eighty per cent conductivity bronze, giving a copper equivalent of 1,000,000-c.m. This is increased by an additional 500,000-c.m. messenger, over the westbound track, for 3100 feet west of Mole substation, and over the eastbound track for 4000 feet east of Sterling substation. Somewhat lighter construction is used in the Yard and part of the San Francisco loop.

PULL-OFFS

The alignment of the catenary has been held, at all points, within the limit of nine inches from the center of the pantograph. This led, especially in the San Francisco loop with its sharp curves and numerous turnouts, to a complicated system of pull-offs. Around the curves, even though the catenary bridges are spaced on an average of ninety feet, intermediate pull-offs were required. These pull-offs are attached to floating "bridle beams" which are suspended across the tracks by cables leading back to the catenary bridges.

Floating "Bridle Beams"

CATENARY BRIDGES

On the double deck portions of the structure, the catenary is suspended from the steel and concrete floorbeams supporting the upper deck roadway, and in the terminal, from the steel roof-frames. In the East Bay yard and in the San Francisco loop, the catenary bridges have for their crossbeam, two steel channels split and deepened at the columns. The columns consist of wide flange beams, which for additional strength, are split and widened to form a taper at their lower ends. This design proved economical in first cost, and, because of the total elimination of light lacing and other details, will keep the maintenance painting to a minimum. (Refer to Contracts R-4 and R-7, pages 28 and 37.)

Catenary Bridge Design

Insulation

The fog and salt air conditions in the bay area made generous insulation desirable. Catenary suspension insulation consists of two seven and one-half-inch units with a wet flashover rating of 70-kv. Dead-end insulators are larger. The contact rail insulator supports are four and one-quarter inches high and eight and one-half inches in diameter.

Return Circuit

The return circuit for both systems consists of the steel running rails and guard rails. At standard rail joints two 250,000-c.m. bare gas welded bonds are used. Frog bonds, as well as switch, transposition and fouling bonds consist of two 350,000-c.m. bonds, the fouling bonds being insulated.

At switches on the bridge proper, the ends of the guard rails are connected by insulated 1,000,000-c.m. cables as it was found necessary to maintain the full conductivity of the eight rails on the bridge.

Guard Rails Terminated

At expansion joints, the guard rails themselves are, from an electrical standpoint, terminated, but are connected across the joints by 1,000,000-c.m. cables supported on the same brackets that support the third rail jumpers.

At approximately every 2500 feet on the Bridge, where broken rail protection is necessary, the running rails of both eastbound and westbound tracks are connected together at the neutrals of the impedance bonds. The guard rails are connected into these cross bonds.

Rails Bonded

In the East Bay yard and the San Francisco terminal area, all rails are bonded together at thousand-foot intervals by 500,000-c.m. or 1,000,000-c.m. cross bonds connected at the neutral points of impedance bonds on signalled track and directly to the rails on nonsignalled tracks.

Tie Stations and Sectionalization

Tie stations for both the 625- and 1300-volt systems are located midway between substations and also at the east end of the Bridge Railway. These tie stations consist of circuit breakers of from 2000 to 4000-ampere capacity, and are used to tie all of the feeders together for better utilization of feeder capacity. In addition, they serve to isolate automatically the various sections in case of fault.

All circuit breakers are equipped to open on failure of voltage or overcurrent. Provision is made to differentiate between overcurrent on useful loads and short circuits, opening on a lower value for the latter.

High-Speed Breakers

For the 1300-volt tie stations, high speed breakers have been provided. For the 625-volt contact rail breakers, where high speed opening would cause a high inductive voltage, semi-high speed breakers were used, and for the 625-volt yard catenaries, only the customary slower speed breakers were installed.

SECTIONALIZING SWITCHES

Manual Switches

As an adjunct to the tie stations to provide for manual sectionalizing, a number of manually-operated switches have been provided. At the San Francisco terminal, their principal purpose is for tying each of the two systems together for better conductor utilization, although they can be used to cut out sections in the terminal.

Disconnect Switches

In the Yard where they may be operated under load, horn gaps have been provided to handle up to 150 per cent of their full load rating. These are used both for grouping and fault sectionalizing. On the Bridge at crossovers, knife blade disconnect switches allow sectionalizing in conjunction with the use of the crossovers. These are similar to the disconnect switches used in the tie stations for isolating the circuit breakers.

TIE STATION HOUSINGS

Steel Cabinets for Tie Station

Enclosures are being provided for the tie station equipment. At the center anchorage, a space thirteen feet by forty-eight feet by sixteen feet high was available in the housing, or hood, of the center anchorage at the track level. For the 1300-volt tie station on the Island, the south side upper-deck approach to the Island roadways was utilized as a roof. Hollow tile side walls were built up, making an enclosure nineteen feet by twenty-nine feet and fourteen feet high. At Pier E-7, a platform was built, supported from the steel trusses, and the tie station equipment built into two steel cabinets, each three and one-half feet square and seven feet high. At the east end of the East Bay yard, the 625-volt station is housed in a structural steel and transite shed and at the Twenty-sixth Street overhead crossing, the 1300-volt station has a similar enclosure.

Expansion Joints

The large movements at various points on the Bridge necessitated the use of elaborate expansion joints in both rail and catenary systems. The catenaries are dead-ended to the floor beams on each side of the expansion joint and a sliding bar installed over the fixed section.

For the contact rails and negative returns, 1,000,000-c.m. insulated cables were attached to each side of the structure and suspended under the fixed section or strut.

Contact Rails

One hundred fifty-pound third rail, with conductivity ratio to copper of 1/6.85 giving a copper equivalent of 2,530,000-c.m., is used for main track 625-volt distribution. This is reinforced on the eastbound track with 1,000,000-c.m. of copper for 2000 feet west of Sterling substation. (Refer also to Contract R-9 and R-21A, pages 45 and 48.)

Bonding Contact Rails

The joints in the contact rail are bonded so as to furnish conductivity equal to the main section of the rail. The 150-pound contact rails were purchased with their heads beveled for half their depth, and the outstanding legs of the base beveled for their entire depth. After the rail was placed in position, these bevels were filled with weld metal by the electric arc process. The web of the rail was ground to remove all mill scale and two heavy copper bars soldered and bolted to the joint. The joint was finished by grinding off excess weld metal. The 55-pound contact rail is bonded by two 250,000 gas-weld bonds as used for the track rails.

Gas-Weld Bonds

Across the Bridge, the contact rails are welded in sections up to 900 feet in length, each section being anchored to the track structure by wood stick anchors. The contact rail jumpers at these expansion joints consist of six 500,000-c.m. rubber jacketed and rubber insulated cables terminating in copper cone terminals which are welded to the contact rail. The feeders to the contact rail are connected in a similar manner.

Progress

Orders for substation equipment were placed by The Pacific Gas and Electric Company, with the General Electric Company and the Westinghouse Electric and Manufacturing Company in the fall of 1937, and the manufacture of this equipment is nearing completion. Contracts have been awarded for the construction of Sterling and Mole substations and work has started at both sites.

CATENARY AND FEEDERS

Bids Opened

Bids for the catenary and feeders were opened October 13, 1937. The low bid was $484,507.00. Some modifications were made in design, the feeder cables from Sterling substation to the terminal added, and the contract readvertised. Bids were again received January 26, 1938, and the contracts (R-10 and R-21C) awarded to Barrett & Hilp of San Francisco and T. L. Rosenberg on the low bid of $370,283.00. Work was begun on February 21, 1938, with the erection of a storehouse and the construction of tower and line cars.

MATERIALS

The material used for all of the overhead system was purchased by the State and delivered to the site. All insulated feeders, tie station equipment, sectionalizing switches, and miscellaneous iron and steel were furnished by the contractor. All catenary bridges were furnished and erected by the State under other contracts. (R-2B; R-4 and R-7.)

All bare wire entering into the catenary systems is either of bronze or copper, both for conductivity and to resist corrosion. Iron or steel is galvanized where used as fittings, and painted if used as a portion of the supporting system.

EQUIPMENT

The principal stringing train consists of a twenty-four-ton gasoline locomotive equipped with an air compressor for air brakes on all cars; one flat car upon which has been mounted an extensible tower platform the size of the car; one flat car on which is mounted an extensible A-frame, tower platform, storehouse and material bins; a flat car arranged for twelve reels and a power winch driven by a gasoline engine.

Equipment Capacity

Each of these flat cars is 100,000 pounds capacity and of standard gauge and with air brakes operated from the locomotive.

Three smaller tower cars are mounted on standard automobile trucks with extensible tower platforms, which can be rotated as desired. These trucks have flanged wheels for rail operation.

Four smaller towers are mounted on push cars for use where motive power is not essential. These towers can be extended but not rotated. Material deliveries from storeroom to the job are made with the customary delivery trucks. Heavy reel deliveries are made with rented trucks and derricks. The reels are picked up from the yard and unloaded into position on the reel car.

BONDING

The contracts (R-11 and R-21B) for the bonding of the track rail and contact rail were awarded to General Welding Company of San Francisco Septemper 24, 1937, on a low bid of $32,527.05. All materials were furnished by the State. Work started January 20, 1938.

Status of Work June 30, 1938

The stringing of the catenary necessarily follows the completion of the trackage. Lack of available trackage has delayed the work so that to date these contracts are six per cent completed.

Track bonding has followed rail laying as closely as practicable and to date this work is thirty-one per cent completed.

Personnel

R. A. Lee is superintendent in charge of Contracts R-10 and R-21C for the contractors, Barrett & Hilp and T. L. Rosenberg.

C. J. Bergundthal is in charge of work on Contracts R-11 and R-21B for the contractors, the General Welding Company.

H. M. Tilson is resident engineer for the State.

Alterations and Additions to Rolling Stock

[[Contracts Nos. R-30; R-31; R-32]]

The proposal to extend the East Bay interurban lines via the Bridge to a terminal in San Francisco involved considerable changes to the rolling stock of the three companies. The longer trips, the grades on the Bridge, the speed required in making up trains, and the adopted signal system were factors in determining the extent of this work. Provisions for these changes were included in the agreement of March 6, 1936, between the California Toll Bridge Authority and the Interurban Electric Railway Company, and Key System, respectively, and in the agreements now being negotiated with the Sacramento Northern.

Interurban Electric Railway Company (Contract No. R-30)

Alterations Described

The equipment of this company consists of eighty-five motor cars, twenty-one operating trailers, and thirty-nine non-operating trailers, a total of 145 cars. This equipment is of comparatively modern steel construction. The alterations necessary to meet the requirements of Bridge operations are as follows:

Automatic couplers	145 cars
Rewire heater circuits	145 cars
Install cab signals	110 cars
Alterations to air brakes	145 cars
Platform gates and window stops	145 cars
Sanders	110 cars
Window wipers	110 cars
Motorize trailers	10 cars
Emergency lighting	145 cars
Destination signs	145 cars

Total estimated cost is $1,330,000.

This work is being done by Southern Pacific forces at their West Alameda shops, under the direct supervision of Assistant Master Mechanic L. A. Mitchell. Work started in the fall of 1937 and was thirty-eight per cent completed as of June 30, 1938.

Key System (Contract No. R-31)

At the time of executing the agreement of March 6, 1936, the Key System had the following equipment:

71—Wood body motor cars;
9—Wood body trailers;
34—Steel body motor cars;
1—Steel body articulated unit.

Key System Units

For the Bridge operation, the Key System required eighty-eight articulated units. The management of that company utilized as much salvage from their existing equipment as possible. In general, this salvage consisted of trucks, motors, underframes from the steel body cars, automatic couplers, and pantographs. The result will be eighty-eight articulated units, 110 feet long with seats for 124 passengers. The estimated cost of the entire program is $3,500,000—of which the State has furnished $2,470,000. The balance will be financed by the Key System.

New Units Purchased

The first step in the Key equipment program was the purchase of twenty-three new units. The delivery of these in the fall of 1936 allowed the Key to put them in regular service and gradually build sixty-five additional units. The new units were manufactured by the Bethlehem Steel Company. The rebuilding of the sixty-five units has been done at the Key Emeryville shops. Chief Engineer S. G. Culver has been in charge of the work.

Sacramento Northern Railway (Contract No. R-32)

The contract now being negotiated between the California Toll Bridge Authority and Sacramento Northern provides that the Authority finance the cost of such alterations to the Sacramento Northern equipment as are necessary to provide for the operation of such equipment across the bridge. The work will consist of cab signals and alterations to motors on seventeen motor cars. The cost is estimated at $80,690.00.

Contracts To Be Let

Contracts remaining to be let, including Contract R-32, Sacramento Northern Railway alterations, described above, comprise the erection of inspection buildings in the yard (Contract No. R-8) and the installation of a telephone system (Contract No. R-6).

Inspection Buildings

Seven structures will be erected under this contract, which will be awarded in August.

The structures involved are the Southern Pacific car inspection building and annex; Key System car inspection building and annex; Sacramento Northern inspector's house; Southern Pacific oil house; Key System oil house; Southern Pacific shoe pit; and Sacramento Northern shoe pit.

Telephone System

Bids for this contract will be advertised in October. The installation will provide a telephone connection to all parts of the Bridge Railway system.

Estimated Cost of Contracts to Be Let

R-6	Telephone system	$80,000.00
R-8	Buildings, East Bay yard	157,000.00
R-32	Sacramento Northern Railway changes	81,000.00
		$328,000.00

Electrical Work, Main Bridge and Approaches

⟦Contracts Nos. 11 and 11A⟧

The contract for roadway lighting and general electrical work on the Bridge and its approaches had been practically completed before the start of the last fiscal year. The co-contractors were Alta Electric & Mechanical Company and the American Building & Maintenance Company.

Bridge Electrical Work Completed

During July, 1937, and the early part of August various tests were performed on the system and miscellaneous cleanup work was executed by the contractor. The bridge maintenance force had joint control of the remaining installation since the opening of the bridge to traffic November 12, 1936.

Personnel

C. A. Schwartz was in charge of the work for the contractors during the fiscal year.

H. M. Tilson was resident engineer for the State.

Summary

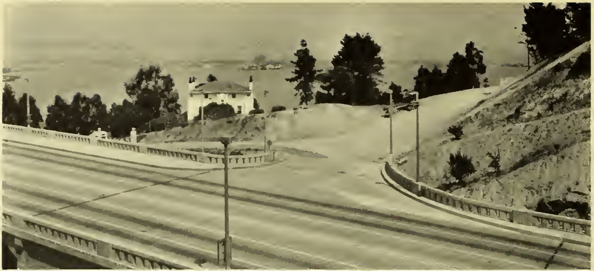
COSTS

Contract No. 11

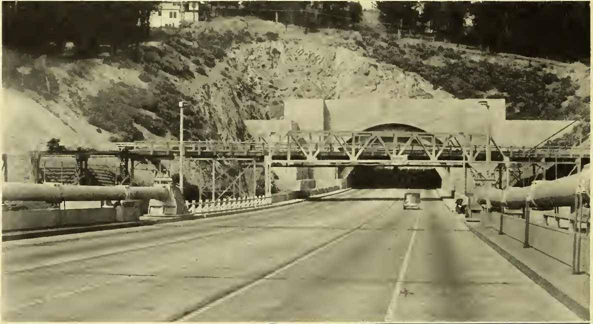
Total contract cost	$353,324.00
Total extra work orders	22,091.19
Total expenditure	$375,415.19

Contract No. 11A

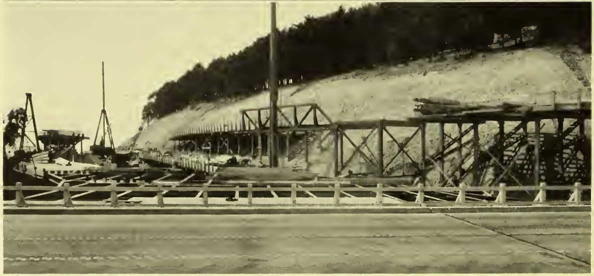
Total contract cost	$89,850.00
Total extra work orders	319.23
Total expenditure	$90,169.23



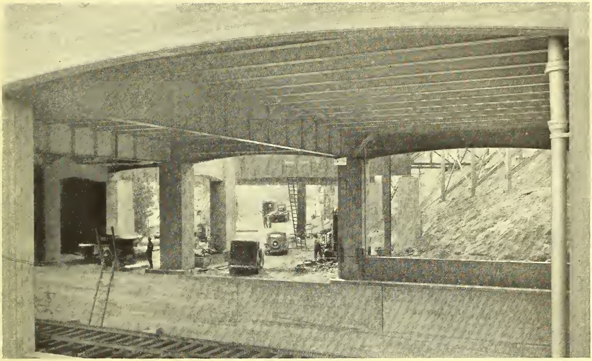
Treasure Island Connections, May 24, 1938
East Portal Connection



Overhead Trestle, West Portal



West Portal Connection



Treasure Island Connection, Lower Deck, May 24, 1938

Yerba Buena Island Toll Plazas

Plans have been completed for two toll plazas on Yerba Buena Island to serve traffic to the 1939 Golden Gate International Exposition on Treasure Island. Bids for construction will be called for shortly.

Island Toll Plaza Costs

It is estimated that these toll plazas, together with pertinent equipment and a traffic control system, will cost approximately $35,000. The Exposition management will participate in the cost of the signal system. The Island Toll Plazas will serve the upper and lower decks of the Bridge. Signals will be placed at the east and west ends of the tunnel where the Exposition roadways connect.

Water Pipe Line Construction

The original grant from the United States Government permitting the State to construct the Bridge through Yerba Buena Island gave to the Government the privilege of placing a water line on the structure.

The then existing submarine line from the Key Mole has not been in service since a fire destroyed the Key Terminal May 6, 1933. In order to provide an adequate fresh water supply to the Exposition and at the same time to supply the needs of Yerba Buena Island, the San Francisco Water Department has installed a ten-inch pipe line across the west crossing of the bridge, in conformity with the original permit.

This pipe line is supported from the upper deck floorbeams. It starts from a "booster" pumping station at the base of Pier W-1 and terminates in a three million gallon reservoir, 260 feet above sea level on the west side of Yerba Buena Island.

Water Line Design Problems

Design of this line involved the major problems of providing for the expansion of the bridge at each of the towers and also the differential expansion between the bridge and the water pipe. A further restriction was that all parts of the installation should clear the path of the maintenance gantry. (Refer to Maintenance, page 82.) Outlets were provided at various intervals along the Bridge for emergency purposes.

The design was developed by the engineers of the Water Department in consultation with the engineer of the Bridge Design Department. The work was installed under the direction of U. S. Army Engineers. Financed as a WPA project, the job was sponsored by the San Francisco Public Utilities Department. The Golden Gate International Exposition provided the required twenty per cent obligation.

Legislative Approaches

Status of Work June 30, 1937

Location, financing, and construction of the legislative approaches to the Bridge as discussed in previous reports (Volumes I, II, III, and IV), were completed for the opening of the Bridge to traffic in November, 1936. Subsequent to that time the only work performed was the propagation of plants for landscaping the eastern approach, until in April of 1938, actual planting was started. The landscaping was done in two parts, as follows:

Plants Propagated

Watering System, Curbs, and Shoulder Widening (Contract 84TC15-84WC6)

A contract was entered into April 22, 1938, to cover the installation of water lines, curbs, parking turn-outs, and shoulder widening preparatory to the actual setting out of plants by State forces. This work covers the section from the easterly end of the Bridge to University Avenue, in Berkeley, on the extension of the legislative approach. The figures shown in the tabulation of Status of Work on Legislative Approaches (page 68) include only the amounts spent between the bridge head and Folger Avenue "Y."

The contract work, which is approximately sixty per cent completed, is under the direction of H. W. Miller, resident engineer.

Williams Brothers and Haas, of San Francisco, are the contractors.

Day Labor Work Order 84T22

Coincident with the starting of the contract work previously described, actual planting was commenced under this Day Labor Work Order by State forces. Plants which were propagated under Work Order 84T2, together with additional nursery stock which was purchased from commercial nurseries, were assembled in the vicinity of the distribution structure, allowed to become acclimated, and then transplanted from the cans, in which they were delivered, to the areas which had been prepared for planting.

Nursery Stock Transplanted

H. W. Miller is resident engineer for this project.

Work on Extensions of Legislative Approaches

38th Street Approach Improved

The central legislative approach on Thirty-eighth Street and Moss Avenue is being improved for a distance of 0.62 mile, from Moss Avenue and Broadway to the intersection of Perry and Vernon Streets in the City of Oakland, under the contract entered into October 1, 1937, between the Union Paving Company and the City of Oakland. This contract, estimated to cost $181,641, is financed from the quarter-cent gas tax fund for State highway routes within cities.

The project is approximately seventy-five per cent completed at this time.

The progress of the legislative approach projects is under the general direction of Col. Jno. H. Skeggs, District Engineer, District IV, Division of Highways, and under the direct supervision of P. O. Harding, assistant district engineer.

Statement of Receipts and Expenditures

From September 14, 1932, to June 30, 1938

RECEIPTS		
Bonds sold to R.F.C. 4%	$33,000,000.00	
4¼%	34,000,000.00	$67,000,000.00
Interest received from banks		62,393.67
From revenue fund		750,000.00
Series A bonds		650,000.00
		$68,462,393.67
CONSTRUCTION EXPENDITURES		
Vehicular bridge	$54,607,704.61	
Interurban	13,176,434.66	$67,784,139.27
Construction fund balance (State Treasurer)		678,254.40
		$68,462,393.67

EXPENDITURES—INTERURBAN

	Engineering and design	$569,274.63	
	Legal	43,030.59	
	Property	3,216,276.81	
	Interest and discount	322,351.04	
	Insurance	22,000.00	
	Administration	72,283.14	
	Consulting architects	81,108.55	
			$4,326,324.76
	CONTRACT PAYMENTS		
R- 1	Demolition	$121,175.00	
R- 2A	San Francisco terminal—general construction	1,204,485.87	
R- 2B	San Francisco terminal—structural steelwork	328,525.20	
R- 2C	San Francisco terminal—mechanical	67,840.52	
R- 2D	San Francisco terminal—electrical	29,754.00	
R- 3	San Francisco viaduct	419,262.86	
R- 4	Substructure—East Bay yard	459,219.78	
R- 5	Signals and interlocking	623,835.27	
R- 7	Superstructure, East Bay yard	456,843.05	
R- 9	Trackwork and contact rail	291,473.41	
R-10	Overhead and feeders	18,903.75	
R-11	Track bonding	3,950.10	
R-21A	East Bay yard—trackwork	302,387.35	
R-21B	East Bay yard—bonding	3,855.28	
R-21C	East Bay yard—overhead and feeders	15,693.67	
R-21	East Bay yard—Key System	267,098.13	
R-22	Southern Pacific connections	136,597.71	
R-23	Southern Pacific-Santa Fe interchange yard	29,498.00	
R-30	Interurban Railway—equipment changes	357,923.78	
R-31	Key System—equipment changes	2,470,000.00	
R-33	Off-line connections	749.75	
	Construction materials	1,241,037.42	$8,850,109.90
			$13,176,434.66

EXPENDITURES—VEHICULAR BRIDGE

Engineering	$363,311.34	
Triangulation and survey	252,576.09	
Administration	578,691.32	
Boat operation	123,788.21	$1,318,366.96
Consulting engineers		519,780.43
Insurance		434,887.74
Legal		136,775.54
Property		2,147,468.96
Rental Pier 24		90,591.25
Moving cables		110,316.65
Inspection		329,532.21

CONTRACTS COMPLETED

1.	Foundation borings	$639,196.61
2.	Substructure west bay	7,474,759.14
3.	San Francisco anchorage	1,084,247.80
4.	Substructure east Bay	4,580,189.88
5.	Yerba Buena Island crossing	2,352,208.04
6.	Superstructure west bay	14,484,625.20
7.	Superstructure, east bay	9,219,302.02
8.	Girder spans	263,170.95
9.	Final field painting	887,446.86
10.	Administration building	353,056.27
11.	Electrical work	375,415.19
12.	Traffic signs	4,863.07
13.	Tunnel lining	55,563.87
14.	Island garage	14,476.66
15.	San Francisco section	817,216.63
16.	Operating equipment	102,822.29
17.	Island fencing	7,063.69
18.	Fireproofing outside hazards	155,397.17
	Field engineering and expense all contracts	1,069,449.97
	Interest and discount*	5,579,513.56
	Total vehicular bridge	$54,607,704.61

*Interest	$5,063,614.42
Discount	+1,731,482.89
	$6,795,097.31
Rebate— Interest	—$1,215,583.75
	$5,579,513.56

STATUS OF WORK ON LEGISLATIVE APPROACHES TO SAN FRANCISCO-OAKLAND BAY BRIDGE

Contract No.	Description	Estimated cost including contingencies	Estimated total work done to July 1, 1938	Percentage complete	Contractor
64TC6	Dredger fill	$961,770.45	$961,770.45	100	American Dredging Company
64TC8	Rock wall	279,488.61	279,488.61	100	Fredrickson & Watson and Fredrickson Bros.
64TC16	Pabco subway	26,336.10	26,336.10	100	Healy-Tibbitts Construction Co.
64TC24 (15A)	San Francisco approaches	555,000.00	539,948.05	100	Healy-Tibbitts Construction Co.
64TC26–84TC1	Distribution structure	1,185,000.00	1,180,568.85	100	Barrett & Hilp
64TC29	Folger Avenue underpass	131,800.63	131,800.63	100	J. F. Knapp
84TC2 (11A)	Lighting approaches	92,000.00	90,169.22	100	Alta Electric & Mechanical Co., Inc., and American Building Maintenance Co.
84TC3	San Pablo underpass	375,000.00	374,443.99	100	J. F. Knapp
84TC4	Mole paving	271,376.07	279,904.12	100	Hanrahan-Wilcox Corp.
84TC8	Ashby Avenue connection	31,400.00	31,322.90	100	L. C. Seidel
84TC9	Landscaping, Fifth Street plaza	16,000.00	16,210.71	100	California Nursery Co.
84TC10	Cypress Street, Thirty-fourth to Seventh	140,000.00	135,916.97	100	Hanrahan Co.
84T8	Lighting (from distribution structure to Folger Avenue)	31,700.00	21,433.18	100	Work done by State forces
84T10	Traffic stripes	1,825.00	1,574.56	100	Work done by State forces
84T9	Traffic signs	18,000.00	18,905.61	100	Work done by State forces
84T11	Highway patrol shelters		454.00	100	Work done by State forces
	Landscaping East Bay fill	50,000.00			
84T2	Propagation of plants		5,728.53	11.5	Work being done by State forces
84T22	Preparing ground and planting		4,760.10	9.5	Work being done by State forces
84TC15	Water lines, curbs, shoulder widening		5,454.00	10.5	Williams Bros. & Haas
	Subtotal	$4,171,696.86	$4,106,919.97	98.5	
	Engineering	402,000.00	387,523.93	96.5	Includes preliminary investigations, borings, surveys, design, construction, laboratory and R.O.W. Engineering complete.
	Subtotal	$4,573,696.86	$4,494,443.90	98.5	
	Property	*2,220,000.00	*2,106,055.44	95	
	Totals	$6,793,696.86	$6,600,499.34	98	

*Includes $480,152 property used jointly by highway approaches and bridge interurban railway.

STATUS OF RIGHT OF WAY DEEDS ON JULY 1, 1938

Line		Total No. of deeds	Deeds executed			
			No.	Net cost (Not including rental credits nor cost of title reports, insurance, engineering, legal expenses, contingencies, etc.)		
				Land	Improvements, etc.	Total
Bridge	Original line	60	60	$805,394.45	$539,817.36	$1,345,211.81
	Stillman street change	47	47	401,037.00	341,910.91	742,947.91
Total		107	107	$1,206,431.45	$881,728.27	$2,088,159.72
S. F. Bridge Approaches	Fifth Street approach	11	11	$222,193.75	$174,890.14	$397,083.89
	"On" ramp	8	8	122,520.50	30,462.12	152,982.62
	"Off" ramp	34	34	220,560.80	323,581.75	544,142.55
	Account of regrade	18	16	71,514.25	50,429.17	121,943.42
Total		71	69	$636,789.30	$579,363.18	$1,216,152.48
Alameda County Bridge Approaches	Cypress Street	89	88	$188,509.20	$152,407.11	$340,916.31
	Thirty-eighth Street	90	88	217,875.16	184,843.91	402,719.07
	Ashby Avenue	43	38	142,804.13	41,739.21	184,543.34
Totals		222	214	$549,188.49	$378,990.23	$928,178.72
Grand totals		400	390	$2,392,409.24	$1,840,081.68	$4,232,490.92

STATUS OF BRIDGE RAILWAY RIGHT OF WAY ON JULY 1, 1938

	Total No. of deeds	Deeds executed			
		No.	Net cost (Not including rental credits, nor cost of title reports, insurance, engineering, legal expenses, contingencies, etc.)		
			Land	Improvements, etc.	Totals
City and County of San Francisco	42	41	$1,191,477.60	$1,791,829 06	$2,983,306.66
Alameda County	14	6	84,519.24	26,503.38	111,022.62
Totals	56	47	$1,275,996.84	$1,818,332.44	$3,094,329.28

DANIEL E. MORAN

Daniel E. Moran, consulting engineer of the San Francisco-Oakland Bay Bridge, died at Mendham, New Jersey, July 3, 1937. He was seventy-three years old.

Mr. Moran's great contribution to the construction of the Bay Bridge was his work in connection with the compressed air-flotation caissons of the West Crossing, which he designed in collaboration with the Chief Engineer and his Staff.

His death is deeply felt by his engineering associates of the State Department of Public Works, and by the California Toll Bridge Authority.

. . . PART II . . .

OPERATION AND MAINTENANCE

Operation and Maintenance

During the fiscal year, July 1, 1937, to June 30, 1938, a total of 8,673,669 vehicles crossed the Bridge. Gross receipts from Bridge operation were $4,884,033.92.

Costs

The cost of operation and maintenance was $451,422.74. This operation and maintenance cost is paid from gas tax funds. (Refer to Table I, page 85.)

All money collected from Bridge tolls, rentals, and leases is pledged to the sole purpose of:

1. Paying use and occupancy insurance, compensation and expenses of the fiscal agent, the paying agent, the registration agent, the collection agent, and subagents.
2. The interest payments on bonds.
3. The principal amount of all bonds.
4. Reserve fund payments.

A summary of the operating-financial statement from November 12, 1936, to June 30, 1938, is given in Table II, page 85. The financial statement of the revenue account at the close of business June 30, 1938, is shown in Table III, page 86.

Status of Financing

Bond Authorization

On June 30, 1938, the end of the 1937-1938 fiscal year, there were outstanding $33,000,000 serial bonds bearing four per cent interest and $34,000,000 sinking fund bonds bearing four and one-fourth per cent interest. The maximum authorized amount of bonds is $33,000,000 serial bonds and $40,000,000 sinking fund bonds with a further provision in the bond agreement that an additional amount of $4,000,000 sinking fund bonds may be issued for the purpose of purchasing competing ferries if and when such purchase is made legal by an act of the State Legislature.

Use of Bond Issue Proceeds

On June 30, 1938, all bonds issued are owned and held by the Reconstruction Finance Corporation. It is estimated that the fully authorized issue of bonds—*i.e.*, $33,000,000 serial and $40,000,000 sinking fund bonds—will be sold to the Corporation by November 1, 1938. The proceeds of this bond issue, plus an amount of $1,010,000 taken from operating income (under permission of the Reconstruction Finance Corporation) have been or will be used to complete the construction of the vehicular bridge and interurban facilities and to retire $260,000 in Series A bonds.

History of Financing

Inasmuch as financing for the Bridge was completed during the fiscal year, it seems pertinent to summarize the history of financing: (Refer also to Volumes I and IV.)

First RFC Agreement

The original financing of the vehicular bridge was obtained by agreement with the Reconstruction Finance Corporation dated December 15, 1932. At that time a sum to net the California Toll Bridge Authority $62,050,000 was authorized, bearing a rate of interest to yield the Reconstruction Finance Corporation five per cent to maturity. To net this amount, bonds in the amount of $63,339,000 were issued bearing a coupon rate of four and three-fourths per cent discounted to yield five per cent. On April 1, 1934, by Presidential order, an interest rebate of three-fourths of one per cent was authorized to March 1, 1939, and as a result, interest rebates were made up until April 21, 1938, at which time the former loan was refinanced and an additional loan was made for interurban construction. All rebates then reverted to the construction fund, amounts so refunded being shown in the financial statement in Table IV, page 87.

New RFC Bond Agreement

On March 8, 1938, the Reconstruction Finance Corporation authorized the use of $750,000 from operating revenue to continue construction work on the interurban until a new bond agreement could be consummated which would increase the total bond issue to an amount sufficient to complete interurban facilities. Such an agreement was consummated following a resolution of the California Toll Bridge Authority on April 21, 1938, authorizing a total issue of $33,000,000 serial bonds at four per cent due serially from March 1, 1939, to March 1, 1964, inclusive; and $43,000,000 sinking fund bonds at four and one-fourth per cent due September 1, 1976. This issue replaced bond for bond the original $63,339,000 outstanding and authorized a principal amount of $9,661,000 additional to complete construction. The $750,000 released by the Reconstruction Finance Corporation from operating revenue for construction and the $260,000 for redemption of Series A bonds was not repaid to the operating fund, the total bond issue having been reduced from $74,000,000 to $73,000,000 in lieu thereof.

Four Million Dollar Additional Authorization

In addition to the $73,000,000 authorized, under the above resolution and agreement, there is an added authorization of $4,000,000 provided for in the resolution which may be used for the purpose of ferry purchase when and if such purchase is authorized by law.

Bond Sale Profits

A provision of the bond sale agreement with the R.F.C. stipulates that if the R.F.C. resell the bonds within a period of nine months after April 21, 1938, the State of California shall participate to the amount of fifty per cent in all bond sale prices over 101.

Bridge Traffic

Toll schedules in effect, amount and classification of traffic; traffic receipts and expenses; and traffic distribution are shown in Tables V, VI, VII, and VIII, respectively, on pages 88, 89, 90, 91.

Bridge Competition

Effect of Ferry Rate Reductions

Previous to August 12, 1937, the toll schedules on the Bridge and on the Southern Pacific-Golden Gate automobile ferries, which are in direct competition with the Bridge, were for all practical purposes the same. During the six months' period prior to August 1, 1937, vehicles at the rate of 10,100,000 per year crossed the Bridge, and vehicles at the rate of 400,000 per year crossed by ferry. On August 12, 1937, by order of the Railroad Commission, toll schedules on the ferries were reduced to an average fare base of approximately 31/53 of those in effect on the Bridge. A a result of this drastic reduction of tolls on the competing ferries, there was an immediate and large reduction in bridge traffic with a correspondingly large increase in ferry traffic.

From September 1, 1937, to July 1, 1938, vehicles at the rate of 8,400,000 per year have been traveling the Bridge, and vehicles at the rate of 3,190,000 per year have used the ferries.

During this same period, the passenger interurbans have lost at the rate of approximately 2,660,000 passengers per year, which is equivalent to 1,210,000 automobiles at the rate of 2.2 passengers per car. Combining these figures, it is found that there has been a slight decrease in total transbay traffic during the past ten months, and there has been a very marked redistribution between Bridge, ferries, and interurban. This redistribution is clearly brought out in the following table:

Transbay Traffic

	Traffic prior to toll reduction on ferries Annual Rate	*Traffic since toll reduction on ferries Annual Rate*
Bridge	10,100,000	8,400,000
Ferries	400,000	3,190,000
Interurban*		
Key	5,680,000	5,135,000
S. P.	5,700,000	5,010,000
Total transbay	21,880,000	21,735,000

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* Total passengers reduced to equivalent vehicles by dividing by 2.2, the average number of passengers per car crossing the bay.

The reduction in transbay traffic during the past ten months is no doubt due in part to the business depression during that period in the bay area. During the last ten months the Bridge lost 16.8 per cent in traffic and income; the Key Route interurban, 9.6 per cent; the Southern Pacific interurban, 12.1 per cent; and the ferries gained 697 per cent in number of vehicles and 143 per cent in income. The Bridge has lost in actual income at the rate of approximately $895,000 per year.

The entire redistribution of traffic and the attendant losses and gain can without doubt be attributed to the radical difference in toll rates between Bridge and ferries and not to inducement of additional travel by the lower toll schedules on the ferries.

Reduction in Tolls

On May 1 of this year, the California Toll Bridge Authority authorized a reduction of truck tolls from $0.75 to $0.60, and freight tolls from $0.60 per ton to $0.40 per ton. This has had a stimulating effect upon this type of traffic and has placed the Bridge in a somewhat better competitive position.

Truck Traffic and Freight Increased

Although the total amount of money received during May and June for truck and freight tolls represents a reduction of 12.6 per cent from March and April, 1938, the increase in volume of truck traffic approximated eleven per cent while tonnage of freight increased twenty-four per cent. The increase in volume for May and June, 1938, over the same months of 1937 was twenty-five per cent on trucks and 46.4 per cent on tonnage.

As shown in Table VIII, page 91, the redistribution of the total volume of freight transported across the bay during the months of May and June, 1938, favored the Bridge by several per cent when compared with previous months.

Daily average of vehicles and receipts for 1936, 1937 and 1938, by three month periods, is given in Table IX, page 92.

Accounting

The accounting department functions to keep the costs of bridge operations, to reflect the statistics of traffic, and to make such records and reports as may be required.

The personnel is directed by the office engineer with assistant supervising account clerks.

The method of accounting conforms to the general State system of accounts with such modifications as are necessary to meet the exigencies of this individual operation.

Accounting Routine

The daily routine covers:

Records of daily traffic and collections.
Cash reports and deposits by cashiers.
Credit applications and approvals.
Billing of charge accounts.
Compilation of traffic records.
Purchase requisitions.
Clearance and scheduling of incoming bills.
Filing and stenographic work.

The toll collector places his daily collection in a sealed pouch with his own record of cash and charge tickets. The pouches are dropped through a special chute into the cashier's vault. Receipts are counted, checked and verified by the two cashiers. (Refer to Volume IV.)

Duties of Cashiers

The duties of the cashiers are to receive and count collections daily, to make daily deposits to banks, and to verify these records to the accounting room. Banks make daily collections according to schedule. The original deposit receipts signed by the bank collectors and cashier are sent to the proper State officials daily with copies to the bookkeeping department for posting. The cashier's room is equipped with a counting machine for coins.

All collectors' and sergeants' change funds and cashier's cash are checked monthly by the office engineer and assistant, and a report made verifying the audit.

TRAFFIC RECORDS

Tapes Basis of Daily Traffic Count

Each morning the record tapes are taken out of each lane register by one of the account clerks. From these tapes the daily record and liability of each collector is compiled. Subsequently these are checked with the cashier's record of each collector's cash and verified as correct, over, or short. All discrepancies are investigated as well as compared with the record of the axle counters. All statistics of traffic and toll revenue are compiled from these daily reports. All passes, bus slips, and charge account tickets for trucks and freight are deposited with the collector's cash records to the cashier. These are sent to the accounting room by the cashier. Four account clerks are assigned to this work.

CREDIT ACCOUNTS

The supervising account clerk is in general charge and personally handles the credit applications that are made from firms desiring charge accounts. All applications are checked for rating with Dun & Bradstreet and are referred to the principal bridge engineer for final approval. Credit cards are then issued to approved firms which authorize the toll collectors to make charge slips for their accounts. Those applicants which can not be rated as satisfactory are required to file a surety bond. To date no losses have resulted from the extending of monthly credit accounts.

ROUTINE ACCOUNTING

The details of handling all incoming bills, schedule work, time cards, purchases, filing, stenographic, and the peg board operations of the accounting room are all under the same general supervision.

BOOKKEEPING AND BILLING

Credit Accounts

All charge slips received from the lanes through the toll collectors are sent to the billing room. This room is equipped with two bookkeeping machines, one Sortergraph, two adding machines, two typewriters, and steel lock cases for the ledger cards and charge account records.

This work is done under the charge of a supervising account clerk with three bookkeeping machine operators and one junior clerk for the Sortergraph machine.

The charge slips are sorted and arranged into alphabetical order on the Sortergraph, verified, and passed to the billing clerks.

All checks for accounts receivable are sent to the bookkeeping room, posted, and taken to the cashier who receives and signs for them.

There are now some 330 active weekly, semimonthly, or monthly accounts. The June record shows 419 renditions, nearly 900 sheets, over 30,000 postings. Monthly bills are mailed out about the third day of each month.

MONTHLY STATEMENTS AND SPECIAL REPORTS

Monthly reports are made by the accounting department to the principal bridge engineer as follows:

Financial receipts and expenditures.
Detailed report of traffic.
Commute book traffic record.
General report of whole month's performance.
Certification of cash audit.
Comparison of expenditures vs. budget estimate.

Special Reports

Special reports or extracts are prepared when requested by either the chief engineer or principal bridge engineer.

The regulation State financial sheets and records are sent monthly to Sacramento together with certain copies of the above-mentioned reports when requested.

NON-OPERATING WORK

All construction accounts are also kept by this department and the cost of the work prorated to the proper account.

Toll Collection

A toll collection force of forty-three men under the immediate supervision of one toll captain and four toll sergeants operated with increasing efficiency and accuracy during the year. The relatively few complaints received from bridge patrons reflect the courtesy of the toll collection body.

The present force of collectors represents an increase of one collector over last year's crew; however, four men of this group are required to take care of vacation periods, which were not in operation during the last fiscal year, and to man the temporary Treasure Island toll station, which was established on October 27, 1937. Increased experience and efficiency, coupled with reduction of cash tolls to fifty cents, enables collectors to handle a greater number of cars per lane during peak hours. Decreased traffic during the past year probably contributed in part to the average reduction of one collector per shift at the main toll plaza.

Temporary Treasure Island Toll Station

An excellent record of accuracy is shown by an average accumulated error for the year for all collectors of $0.258 per $1,000, and an average net error for the same period of plus $0.027 per $1,000. Overages and shortages are added in arriving at a collector's accumulated errors, but are subtracted in determining his net errors. The low average accumulated error for all collectors for a one-month period amounted to $0.161 per $1,000 in April of this year, and the low net average of plus $0.008 per $1,000 occurred in July, 1937.

High Record of Accuracy

Six toll collectors resigned from the force during the past year for various reasons.

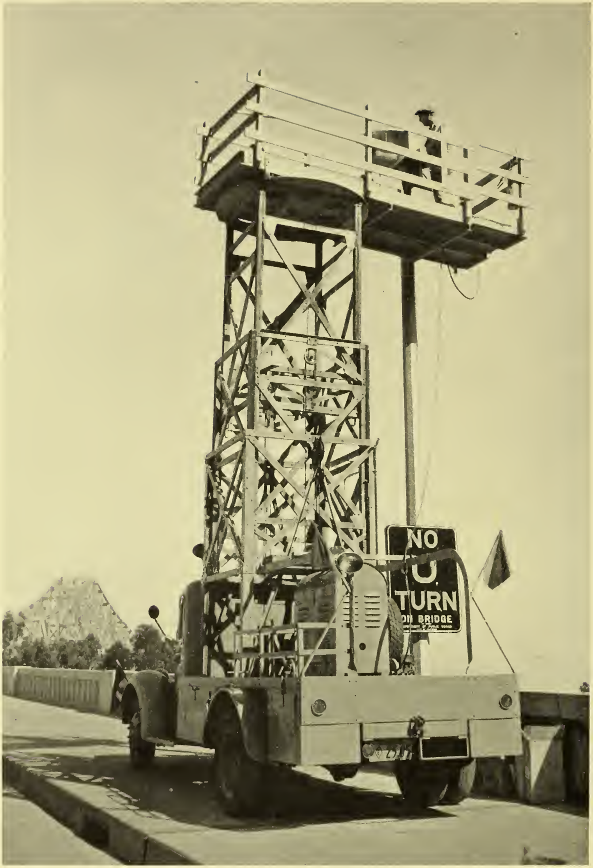
Ten individual collectors' counting booths were built in the Administration Building during the year by maintenance forces and placed in service in the latter part of November, 1937. Installed at a cost of $949.20, the booths furnish an additional safeguard in the toll collection system.

Collectors' Counting Booths

Roadside Service

The emergency roadside service has operated efficiently throughout the year. A total of 6466 services were rendered to bridge patrons during the last twelve months. This represents a slight reduction in rate over the previous seven and one-half-month period during which 1178 vehicles crossed the Bridge for each vehicle serviced. The corresponding rate for the past year was 1341 cars crossing per vehicle serviced. No fatalities have resulted from accidents on the Bridge during the past twelve months. Pertinent information on roadside service is summarized in Table X, page 93.

Roadside Service Calls Reduced



Lamp Testing Through Portable Generator

Electrical

Lower Deck Tunnel Lamps

Since the last annual report (refer to Volume IV), many interesting facts have developed in connection with the operation of the sodium vapor lamps on the Bridge and approaches. The new operating schedule requires that all lights in the lower deck of Yerba Buena Island tunnel burn continuously. Analysis of the records discloses that the lamps in this location had an average life for the fiscal year of 4982 hours, or more than double the average life of lamps on the rest of the installation.

During this same period the lamps on the upper deck of Yerba Buena Island tunnel, which operate on approximately the same schedule as the Bridge and approaches, had an average life of 2278 hours. The corresponding figure for the Bridge and approaches is 2125 burning hours. This points to the conclusion that by far the largest factor affecting the lamp life is the number of times the lamp is turned on and off.

Lamp Replacements

A glance at the table of sodium vapor lamp operations for the fiscal year also discloses the greatest number of replacements occurred on the suspension bridges, with the next largest number on the spans of the East Crossing. Comparing these figures with those of the sheltered and rigid tunnel sections, it infers that the vibrations set up in these resilient structures shorten the life of the sodium vapor lamps to an appreciable degree.

Table XI, page 94, summarizes sodium vapor lamp operation and replacements for the fiscal year.

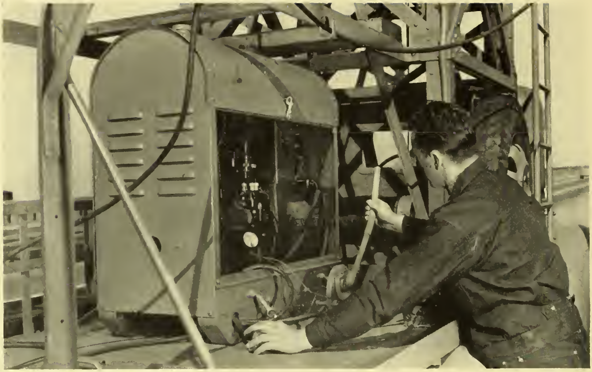
Lamp Tests

Since it became apparent from experience gained in the operation of the electrical system that sodium vapor lamp life was materially shortened by the turning on and off of these lamps daily, the electrical maintenance engineer conceived and developed a means of testing individual lamps without removing or disconnecting them from the circuit and without energizing the entire circuit. A series of tests was conducted with the result that the tower truck is now equipped with a 1500-watt, 120-volt, alternating current, portable generator furnished with long electrical leads and a special plug which is inserted in the film cutout socket. The plant is automatic and starts as soon as the load comes on the generator. Individual luminaires are energized in the same way as under normal operating conditions. The source of trouble, whether relay, film cutout, or lamp, is readily determined and corrected. It is expected in this way to increase the average life of lamps several hundred hours which, taken with the amount of electrical energy saved by elimination of the daily use of circuits for lamp testing purposes, will represent a material saving to the State.

Reflector Corrosion

The corrosion of alzac aluminum surfaces of the sodium vapor luminaires has been the cause of some concern. While a preliminary investigation indicates a comparatively small loss of efficiency as a result of this corrosion, the fact remains that the corrosive action appears to be progressive and it would only be a matter of time before this corrosion would vitally affect the reflecting qualities. Inasmuch as the manufacturer has guaranteed these reflectors, he is now conducting a series of tests on alzac reflecting surfaces prepared by a refined process which, if satisfactory, will be used to replace those units which have failed.

During the fiscal year several items of construction were completed:



Interior View, Portable Generator

NEW BELL STRIKERS INSTALLED

New bell strikers were installed on the five fog bells. The development of this striker in the bridge maintenance shop was described in the annual report of the fiscal year ending June 30, 1937. (Refer to Volume IV.) These bell strikers have been subject to severe use in the past year and have proved entirely satisfactory.

EXTENSION OF EMERGENCY CALL SYSTEM

Tow-Call Box System Extended

The fire alarm and tow-call box system was extended to include the main approach to the Fifth Street Plaza, San Francisco, and also the distribution structure over the Southern Pacific and Key tracks, Emeryville. This increases the total number of tow-call boxes to thirty-eight.

PUBLIC ADDRESS SYSTEM AT TOLL PLAZA

Microphones Direct Traffic

It was observed that the tendency of the average motorist to drive straight ahead and follow the car preceding him tended to congest traffic in the center lanes of the plaza, while other open lanes, requiring a slight turn to the right side of the plaza, remained comparatively unused. To correct this condition, a public address system was installed. The toll sergeant on duty can now, by means of a microphone located at his desk in the Administration Building, address motor vehicle operators approaching the toll gates and direct them to the less congested lanes. This has been very satisfactory and resulted in favorable comment from the motoring public. The system is also of value in directing out-of-town visitors who are unfamiliar with the bridge facilities.

On at least two occasions during the past year when extremely dense fog blanketed the Toll Plaza, the system demonstrated exceptional emergency value in directing traffic.

INTERCOMMUNICATION EXTENDED

To facilitate intercommunication, several additional maintenance telephone plug-in boxes and police telephones were installed, and the auto-call paging system at the Administration Building was connected to the blue police-call lights on the Bridge for flashing coded signals to Bridge personnel.

During the Christmas holidays two large illuminated wreaths, each of which measured ten feet in diameter, were installed over the east and west portals of Yerba Buena Island tunnel which, together with the illuminated Christmas trees at the plaza, constituted the decorations for the season. During this period appropriate phonograph records were also played over the public address system above mentioned. This received much favorable comment from the motoring public.

Painting

Painting Crew Increased

A small painting crew of one foreman and ten men commenced maintenance painting on October 1, 1937. This crew was increased to a foreman and fifteen men during January, 1938. Working time is established on a five eight-hour-day week basis with all regular holidays granted and the usual annual vacation and sick leave benefits of State employees. Personnel is paid a monthly salary established after a due consideration of all the factors entering into working conditions on the Bridge. (Refer to Table XII, page 95.)

Unusually wet weather from October through March, and particularly in the months of January to March, inclusive, greatly hampered actual painting operations. A good portion of the time deemed unsuitable for painting was devoted to cleaning operations so that the actual percentage of totally lost time was not unduly large. A schedule of maintenance painting is shown in Table XIV, page 97.

Certain portions of the east crossing spans had been painted for almost two years at the time maintenance painting was started. It was to be expected that some deterioration of surface would appear in that time. Fortunately the proportion of surface requiring urgent attention was a relatively small percentage of the whole. Bearing in mind the large area that must ultimately be maintained—some 14,000,000 square feet—the surface maintenance problem has been approached with the thought that extra precaution exercised at this time in organizing the crew; in equipping it with proper tools; in study of paint failures and causes, and from this formulating procedure for future protection, would in the long run result in minimum unit costs.

Cause of Paint Failure Studied

Consistent with this approach, there has been close collaboration with the Division of Highways' Testing and Research Laboratory at Sacramento in a program of investigation of typical failures of paint film and the causes of such failure with particular reference to the locality of the Bridge. Necessarily such a program will cover an extended period of time, but it is felt that the initial information obtained warrants a hopeful view of future results. As a direct consequence of the preliminary data, a change was made in the formulation of the final coat aluminum paint applied on the structure to provide an increased resistance to particular corrosive conditions known to be present as a result of these studies. The advantage of thus selecting this protection on the basis of definite knowledge is obvious.

Concurrent with and supplementing studies outlined above, exposure tests are being made of selected paints under both service conditions and on standard test panels.

Indicative of some of the problems connected with maintenance painting, it is pointed out that cleaning of the surface prior to repainting is a more costly and time-consuming operation than the painting itself. Virtually all of the surface to be painted must be cleaned of salt and dirt film. Since, in general, only one or two films of four will have failed, cleaning by brushing and/or washing is indicated rather than the usual sandblasting.

Traffic Protection

Consideration of traffic protection on such a heavily traveled way as the Bridge is an item that virtually precludes use of the sandblast, even where that process would be the most economical. The same consideration in part weighs against the use of spray painting on maintenance, except for possibly some twenty per cent of the surface below the lower roadway level. The spotty nature of this work would in any case greatly reduce the economy of spray painting over hand brushing. An additional feature that will shortly make spray painting too hazardous on a good portion of the roadway steel will be the high voltage catenary and third rail power systems for the interurban trains, soon to be completed.

ot Painting Procedure

Present procedure on spot painting is to brush failed areas with pneumatic steel power brushes and follow with two coats of standard lead paints and a final coat of aluminum. Special coatings, such as coal tar paint, are applied to the surface on areas in which lead or aluminum paints are not considered effective protection.

Major equipment for the painting crew, placed on the job during the past year, includes:

(a) A painting gantry on the lower deck designed to ride the maintenance walkway curbs and furnish sufficient clearance for unrestricted flow of traffic on the roadway. A swinging cantilever arm on this gantry provides access to upper roadway floor steel over the interurban tracks without danger to workmen from contact with catenary wires.

(b) One 85 cubic feet portable two-stage compressor on two-wheel mounting.

(c) One 105 cubic feet portable two-stage compressor on two-wheel mounting. Mounting for this compressor was built in the maintenance shop, together with a similar mounting for an older 105 cubic feet compressor inherited from construction.

(d) Twelve pneumatic rotary and angle grinders of several types and makes.

For summary of paint used during the last fiscal year, refer to Table XIII, page 96.

Structural Maintenance

Structural maintenance to date has been of a minor nature and largely confined to expansion grating and fender repair. Maintenance forces have handled this work with the part-time assistance of a diver in the case of fender repairs. No great amount of structural repair is anticipated for some years to come under normal conditions.

Sweeping Operations, Upper Deck

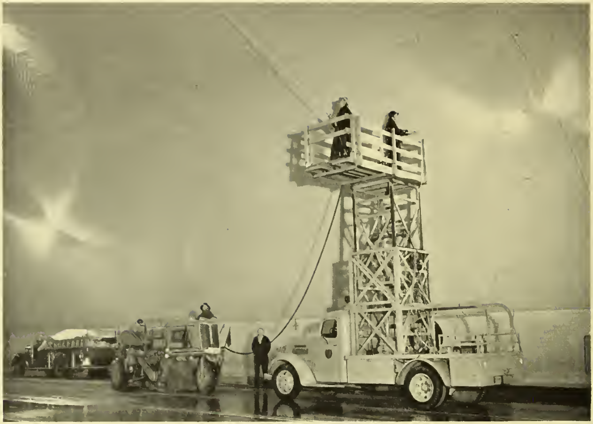
Roadway Maintenance

A small roadway maintenance crew has been kept busy on slope and embankment repairs, correction of drainage obstructions, tunnel washing, weekly sweeping of Bridge, and miscellaneous routine duties. Elevation of pavement on approaches to Bridge and toll lanes, and in the parking areas adjacent to the Administration Building, has been a frequent and recurring operation. Planting and lawn maintenance at the Fifth Street Plaza entrance and the rocky slopes above the Yerba Buena Island tunnel portals have required the full-time services of about two men. Commencing with the 1938-1939 fiscal year, the Fifth Street Plaza is being turned over to District IV of the Division of Highways for future maintenance. Inasmuch as the district will maintain a trained force to care for roadside planting on the East Bay approaches to the Bridge, which extend over a considerable area, they will be able to handle this work more conveniently than bridge forces.

Approach Pavement Elevated

Two major items in non-routine duties completed by the roadway maintenance crew involve the filling of all construction and contraction joints on the Bridge with a rubber latex and SC-4 road oil compound performed in collaboration with the Materials and Research Laboratory, and the bushhammering of some 14,000 square feet of upper deck roadway surface on the Fifth Street approach. This latter

Contraction Joints Filled



Washing Upper Deck of Tunnel

Paving Surface Roughened

was done in an effort to reduce an undue amount of skidding which occurred during the rainy weather of last winter and spring. Generally these accidents were caused in large part by excessive speed for the weather conditions prevailing, but it was felt that additional roughness of surface might prevent some of these. Since this work was completed subsequent to the rainy season, its effectiveness has not been demonstrated. The cost of the work was $648, or $0.047 per square foot.

TABLE I

SAN FRANCISCO-OAKLAND BAY BRIDGE OPERATING EXPENSE

JULY 1, 1937, TO JUNE 30, 1938

Administrative expense	$5,464.51
Supervising engineer and staff (Maintenance)	11,651.91
Roadway, fire and tow service	33,008.35
Bridge structure maintenance and repair	4,272.27
Painting maintenance and repair	35,301.73
Electrical and signal maintenance and repair	27,104.03
Electric energy (power and light)	17,727.83
Shop, auto repairs and stores	16,006.67
Administration building, additions, maintenance and repair	11,762.14
Sprinkler system, Pier 24	5,479.43
Tools and equipment	1,454.12
Floating equipment and operation	1,748.08
Clerical and office staff	36,516.29
Office supplies and furniture	1,860.49
Automobiles	1,205.00
Toll collection	107,779.24
Advertising	1,166.30
MISCELLANEOUS	
Auditing	6,730.00
Legal	3,584.30
Medical	46.79
INSURANCE	
Bridge structure and physical damage	111,600.00
Bonding and burglary	862.84
Compensation	2,020.72
Retirement reserves	7,069.70
	$451,422.74

TABLE II

SAN FRANCISCO-OAKLAND BAY BRIDGE OPERATING—FINANCIAL STATEMENT

NOVEMBER 12, 1936, to JUNE 30, 1938

RECEIPTS			
Toll revenue		$7,904,482.11	
Accrued interest		29,413.38	
Interest from banks		7,781.40	
Rents		1,600.00	
Over and short account		4,936.54	
Commute book suspense		3,607.00	
			$7,951,820.43
EXPENDITURES			
Interest on bonds		$2,949,444.31	
"A" bonds redeemed		260,000.00	
Construction fund		750,000.00	
Use and occupancy insurance		128,000.00	
Loss on counterfeit coins		176.46	
BALANCE ON HAND JUNE 30, 1938			
Accounts receivable	$41,191.50		
Cashier's Cash	43,698.60		
Fiscal agents banks	3,779,309.56	3,864,199.66	$7,951,820.43

TABLE III

SAN FRANCISCO-OAKLAND BAY BRIDGE REVENUE ACCOUNT

FISCAL YEAR JULY 1, 1937, TO JUNE 30, 1938

RECEIPTS			
Toll revenue for year	$4,575,351.35		
Accrued interest on bonds	29,413.38		
Rents	1,600.00		
Interest from banks	3,758.50		
Over and short account	240.33		
Total receipts for fiscal year July 1, 1937, to June 30, 1938		$4,610,363.56	
BALANCES, JUNE 30, 1937			
State Treasurer	$3,128,586.45		
Cashier	53,909.22		
Accounts receivable	30,453.45		
Pickup account	1,020.50		
	$3,213,969.62		
Less commute suspense	610.50		
		$3,213,359.12	
Total receipts			$7,823,722.68
DISBURSEMENTS			
Interest paid on bonds	$2,949,444.31		
"A" bonds redeemed	260,000.00		
To construction fund	750,000.00		
Loss, counterfeit coins	78.71		
Total disbursements, July 1, 1937, to June 30, 1938		$3,959,523.02	
FUNDS ON HAND, JUNE 30, 1938			
Accounts receivable	$41,191.50		
Cashier	43,698.60		
On deposit with fiscal agent	3,779,309.56		
		$3,864,199.66	
Total disbursements and funds on hand June 30, 1938			$7,823,722.68

TABLE IV

SAN FRANCISCO-OAKLAND BAY BRIDGE
CONSOLIDATED BALANCE SHEET
AS OF JUNE 30, 1938

ASSETS

CURRENT ASSETS			
Cash (cashier's account)		$43,698.60	
Construction fund (cash in banks per ledger)		678,254.40	
TOLL REVENUE FUND			
Bank of America N. T. & S. A.		1,895,806.77	
Anglo California National Bank		1,683,502.79	
Anglo California expense reserve		200,000.00	
Accounts receivable (current tolls)		41,191.50	$4,542,454.06
FIXED ASSETS			
Direct Construction Cost—			
(Investment in bridge) Vehicular		$49,028,191.05	
Do. interurban transportation system		12,874,495.31	
Interest during construction	$5,065,593.59		
Less interest rebate from R.F.C.	1,215,583.75	3,850,009.84	
Discount on bonds		2,051,854.76	67,804,550.96
DEFERRED CHARGES			
Prepaid use and occupancy insurance			81,066.74
Total assets			$72,428,071.76

LIABILITIES

FIXED LIABILITIES		
Bonded Debt—		
Serial revenue bonds, 4 per cent	$33,000,000.00	
Series sinking fund revenue bonds, 4¼ per cent	34,000,000.00	$67,000,000.00
DEFERRED LIABILITIES		
Commute books suspense	$3,607.00	
Use and occupancy insurance	46,933.26	
Accrued interest on $67,000,000 bonds—March 1, 1938, to June 30, 1938	921,666.67	972,206.93
Excess of assets over liabilities		4,455,864.83
Liabilities and excess		$72,428,071.76

Note: Above excess of Assets over Liabilities does not take into consideration depreciation or amortization of the investment in bridge facilities over the life of the bond.

TABLE V

TOLL SCHEDULE

Class	Vehicles	Rate	
		July 1, 1937 to April 30, 1938 inclusive	May 1, 1938 and subsequent
1	Automobiles, ambulances, taxis, commercial or light delivery automobiles, all with driver and not to exceed four (4) additional passengers	$0.50	$0.50
	Passengers in excess of four (4) . . . each	.05	.05
2	Trailers drawn by automobiles	.50	.50
	Passengers riding trailer . . . each	.05	.05
3	Trucks (with driver)	.75	.60
	Passengers in excess of driver . . . each	.05	.05
4	Truck trailer	.75	.60
	Passengers riding trailer . . . each	.05	.05
5	Buses with driver	.75	.75
	Passengers in excess of driver . . . each	.05	.05
6	Motorcycle with driver	.20	.20
	Additional passengers . . . each	.05	.05
7	Tricar with driver	.30	.30
	Additional passengers . . . each	.05	.05
8	Vehicles not otherwise specified and/or vehicles requiring a special permit to travel on bridge . . . per 100 pounds	.03	.02
9	Road construction equipment (with driver)	.60	.60
	Passengers in excess of driver . . . each	.05	.05
10	Load carried on any truck or truck trailer . . . per 100 pounds	.03	.02
11	Commute—Passenger automobiles only, with driver and not to exceed four (4) passengers, two (2) one-way trips, undated tickets, for every day of the calendar month except Sundays. (Tickets will be honored on Sundays.) Minimum, fifty (50) one-way tickets; maximum, fifty-four (54) one-way tickets	17.50	17.50
	Passengers in excess of four (4) . . . each	.05	.05
12	Commute—Passenger automobiles only, with driver and not to exceed four (4) passengers, forty (40) one-way trips, undated tickets, in any calendar month. (Tickets will be honored on Sundays.)	. . . .	*14.50
	Passengers in excess of four (4) . . . each	. . . .	.05
13	All classifications to Treasure Island 50% of the above charges	50%	50%

* $14.50 40-trip commute book made available October 1, 1937.

TABLE VI
CLASSIFICATION OF VEHICLES

Period	Automobiles, Automobile Trailers and Light Commercial Vehicles						Buses		Trucks and Truck Trailers		§Motorcycles		‡Special Vehicles		Total	Per cent of Change of Same Month of Preceding Year
	Total		Cash Toll		Commuters											
	Vehicles	Per cent Total	Vehicles	Per cent Autos	Vehicles	Per cent Autos	Vehicles	Per cent Total	Vehicles	Per cent Total	Vehicles	Per cent Total	Vehicles	Per cent Total		
November, 1936	646,027	97.21	641,692	99.33	4,335	0.67	3,364	0.51	9,540	1.43	2,445	0.37	3,208	0.48	664,584	None
December	640,157	95.45	618,424	96.61	21,733	3.39	4,405	0.66	18,896	2.82	2,405	0.36	4,781	0.71	670,644	None
January, 1937	544,773	94.73	518,542	95.18	26,231	4.82	4,230	0.74	17,625	3.06	2,017	0.35	6,427	1.12	575,072	None
February*	635,247	95.16	586,465	92.32	48,782	7.68	3,842	0.58	20,072	3.00	2,373	0.36	6,028	0.90	667,562	None
March	725,466	94.67	666,225	91.83	59,241	8.17	4,659	0.61	26,450	3.45	2,558	0.33	7,182	0.94	766,315	None
April	725,514	94.62	660,364	91.02	65,150	8.98	4,559	0.59	26,807	3.50	3,089	0.40	6,795	0.89	766,764	None
May	848,237	94.67	780,332	91.99	67,905	8.01	8,585	0.96	27,132	3.02	3,954	0.44	8,119	0.91	896,027	None
June	779,679	93.84	713,072	91.46	66,607	8.54	9,109	1.10	29,742	3.57	4,037	0.49	8,300	1.00	830,867	None
July	834,306	94.16	768,427	92.10	65,879	7.90	9,819	1.11	28,974	3.27	4,540	0.51	8,415	0.95	886,054	None
August	802,413	94.01	738,089	91.98	64,324	8.02	9,833	1.15	28,603	3.35	4,471	0.52	8,259	0.97	853,579	None
September	657,779	93.21	603,148	91.69	54,631	8.31	9,462	1.34	26,305	3.73	3,766	0.53	8,392	1.19	705,704	None
October	687,700	93.07	619,352	90.06	68,348	9.94	10,453	1.41	27,931	3.79	3,565	0.48	9,219	1.25	738,868	None
November	649,805	92.93	578,267	88.99	71,538	11.01	10,090	1.44	26,050	3.73	3,133	0.45	10,151	1.45	699,229	None
December	673,934	93.18	599,424	88.94	74,510	11.06	10,675	1.48	26,270	3.63	3,054	0.42	9,348	1.29	723,281	+7.85
January, 1938	625,105	92.96	551,364	88.20	73,741	11.80	10,632	1.58	24,598	3.66	2,915	0.43	9,182	1.37	672,432	+16.93
February	548,982	92.36	477,814	87.04	71,168	12.96	9,423	1.59	23,236	3.91	2,342	0.39	10,395	1.75	594,378	—14.00
March	605,963	91.63	520,795	85.95	85,168	14.05	10,586	1.60	28,713	4.34	2,956	0.45	13,127	1.98	661,345	—15.87
April	634,249	91.45	551,785	87.00	82,464	13.00	10,765	1.55	30,604	4.41	3,324	0.48	14,605	2.11	693,547	—10.56
May†	666,945	91.23	587,631	88.11	79,314	11.89	11,369	1.56	33,918	4.64	3,902	0.53	14,945	2.04	731,079	—25.12
June	642,992	90.03	564,883	87.85	78,109	12.15	11,273	1.58	37,118	5.20	3,838	0.54	18,952	2.65	714,173	—16.34
Totals	13,575,273	93.55	12,346,095	90.95	1,229,178	9.05	167,133	1.15	518,584	3.57	64,684	0.45	185,830	1.28	14,511,504	

*Automobile tolls reduced from $0.65 to $0.50, February 1, 1937.
†Truck tolls reduced from $0.75 to $0.60, May 1, 1938.
§This column includes motorcycles and tri-cars.
‡This column includes automobile and truck passes.

TABLE VII
TRAFFIC RECEIPTS AND EXPENSES SAN FRANCISCO-OAKLAND BAY BRIDGE

Month	1936-37			1937-38		
	Vehicles	Receipts	Operating Expense§	Vehicles	Receipts	Operating Expense§
July				886,054	$469,254.41	$34,046.57
August*				853,579	453,213.40	36,047.49
September				705,704	377,344.65	33,267.53
October				738,868	393,465.25	38,581.73
November	664,584	$442,131.95	$17,385.85	699,229	369,869.90	36,262.88
December	670,644	447,032.15	25,816.67	723,281	380,919.60	33,349.98
January	575,072	382,570.96	26,268.14	672,432	353,859.95	39,328.59
February†	667,562	347,598.10	28,344.06	594,378	313,306.18	35,555.28
March	766,315	400,267.40	30,846.17	661,345	348,235.23	36,322.86
April	766,764	400,564.10	29,381.58	693,547	367,996.88	36,612.96
May†	896,027	469,343.25	28,909.14	731,079	378,289.70	36,086.57
June	830,867	439,622.90	37,606.97	714,173	369,596.20	#55,960.30
Totals	5,837,835	$3,329,130.81	$224,558.58	8,673,669	$4,575,351.35	$451,422.74

*Automobile toll on S. P. Ferries reduced August 11, 1937.

†Automobile toll on San Francisco-Oakland-Bay Bridge reduced February 1, 1937—Truck toll reduced May 1, 1938.

#Audit, heavy equipment purchase and vacation salaries this month.

§Operating expense not assessed against receipts.

TABLE VIII

DISTRIBUTION OF VEHICULAR TRAFFIC AND FREIGHT BETWEEN SAN FRANCISCO AND EAST BAY CITIES, 1937-38

Month	Ferry vehicles				Total Vehicles Other than San Francisco-Oakland Bay Bridge	Vehicles San Francisco-Oakland Bay Bridge	Total Traffic San Francisco-and East Bay	Per cent Carried by Ferries	Per cent Carried by Bridge	Tons of Freight Handled by Ferries	Tons of Freight Handled by Bridge	Total Tons of Freight Handled by Bridge and Ferries	Per cent Handled by Ferries	Per cent Handled by Bridge
	Berkeley	Broadway	Oakland Pier	Alameda										
July, 1937	3,853	216	27,331	1,500	32,900	886,054	918,954	3.58	96.42	22,007	34,176	56,183	39.17	60.81
August, 1937§	*2,221	*162	187,094	6,243	195,720	853,579	1,049,299	18.65	81.35	24,067	34,444	58,511	41.13	58.87
September, 1937			280,159	8,499	288,658	705,704	994,362	29.03	70.97	23,537	32,176	55,713	42.25	57.75
October, 1937			291,101	8,421	299,522	738,868	1,038,390	28.84	71.16	28,610	34,559	63,169	45.29	54.71
November, 1937			274,032	7,846	281,878	699,229	981,107	28.73	71.27	25,395	31,174	56,569	44.89	55.11
December, 1937			249,348	7,541	256,889	723,281	980,170	26.21	73.79	19,407	29,799	49,206	39.44	60.56
January, 1938			253,361	7,210	260,571	672,432	933,003	27.93	72.07	19,011	27,864	46,875	40.56	59.44
February, 1938			224,957	6,767	231,724	594,378	826,102	28.05	71.95	17,245	26,949	44,194	39.02	60.98
March, 1938			253,371	7,884	261,255	661,345	922,600	28.32	71.68	21,152	34,228	55,380	38.19	61.81
April, 1938			262,175	8,313	270,488	693,547	964,035	28.06	71.94	19,423	37,349	56,772	34.21	65.79
May, 1938†			278,487	9,223	287,710	731,079	1,018,789	28.24	71.76	18,601	42,507	61,108	30.44	69.56
June, 1938			271,332	9,249	280,581	714,173	994,754	28.21	71.79	20,341	46,399	66,740	30.48	69.52
Totals	6,074	378	2,852,748	88,696	2,947,896	8,673,669	11,621,565	25.37	74.63	258,796	411,624	670,420	38.60	61.40

*Discontinued August 15, 1937.

§All ferry rates reduced August 11, 1937.

†Truck tolls on bridge reduced May 1, 1938.

TABLE IX

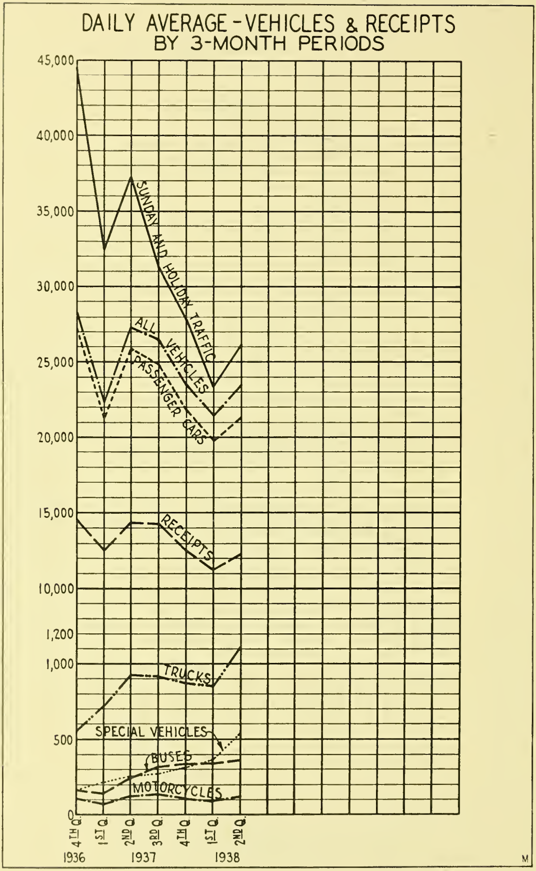

DAILY AVERAGE - VEHICLES & RECEIPTS
BY 3-MONTH PERIODS
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
1,200
1,000
500
0
SUNDAY AND HOLIDAY TRAFFIC
ALL VEHICLES
PASSENGER CARS
RECEIPTS
TRUCKS
SPECIAL VEHICLES
BUSES
MOTORCYCLES
4TH Q.
1ST Q.
2ND Q.
3RD Q.
4TH Q.
1ST Q.
2ND Q.
1936
1937
1938
M

TABLE X

ROADSIDE SERVICE AND ACCIDENTS SAN FRANCISCO-OAKLAND BAY BRIDGE

JULY 1, 1937, TO JUNE 30, 1938

Roadside Service, Bridge and Approaches	July 1, 1937 to June 30, 1938	Total Since Opening of Bridge
Vehicles supplied with gasoline, oil and miscellaneous services	246	6,246
Vehicles towed (engine trouble, no spare tires, accidents, etc.)	144	3,428
Tires changed	86	1,692
Fires	3	57
Total vehicles serviced	479	11,423
Average number of vehicles serviced per day	15.97	19.17
Number of vehicles crossing bridge per vehicle serviced	1,491	1,270

Accidents on Bridge	July 1, 1937 to June 30, 1938	Total Since Opening
Total accidents	1	90
Involving personal injury	1	46
Persons injured	3	92
Fatal accidents	0	4
Property damage only	0	44

TABLE XI

SODIUM VAPOR LAMP OPERATION

JULY 1, 1937—JUNE 30, 1938

Total number of luminaires, bridge and approaches	1,081
Total number of burned-out lamps replaced	1,911
Average burning hours for system except tunnel, lower deck	3,459
Average burning hours for tunnel, lower deck	8,155
Average burning hours per lamp of burn-outs plus originals still in service	2,125
Per cent lamps replaced to total luminaires	177%

SEGREGATION—LAMP REPLACEMENTS

	Total Luminaires	Replacements	Per cent Replacements	Average Burning Hours Per Lamp
San Francisco approaches	108	182	169	2,223
Suspension bridges	244	465	191	1,936
Tunnel, lower deck (circuits 9 and 10)	17	21	124	4,982
Tunnel, upper deck	14	27	193	2,278
East portal of tunnel to E-28	226	421	186	2,089
East Bay approaches — distribution structure and East Shore Highway	472	795	168	2,139

TABLE XII

SAN FRANCISCO-OAKLAND BAY BRIDGE

MAINTENANCE PAINTING—LABOR SUMMARY—ACTUAL TIME IN MAN HOURS

YEAR ENDING JUNE 30, 1938

Month	Average crew	Painting (Includes Cleaning)				Maintenance, cleaning	Harbor Pier 24-26	Miscellaneous work	Lost time	Total man hours
		1st Coat	2d Coat	3d Coat	4th Coat					
October	10	1,064	0	0	0	48	0	360	0	1,472
November	10	1,517	48	0	0	0	0	35	0	1,600
December	9	1,069	46	0	0	70	0	142	369	1,696
January	12	420	234	0	0	928	0	284	150	2,016
February	14	104	0	0	0	578	392	220	826	2,120
March	14	160	136	0	0	48	2,044	66	98	2,552
April	14	1,273	737	0	0	33½	16	248½	44	2,352
May	14	1,982	316	0	0	0	0	54	0	2,352
June	14	477	327	630	730	0	0	292	0	2,456
Totals		8,066	1,844	630	730	1,705½	2,452	1,701½	1,487	18,616
Percentage		43.4	9.9	3.4	3.9	9.2	13.2	9.1	7.9	100

These figures do not include time of one truckdriver and one foreman continuously employed from October 1, 1937, to June 30, 1938.

TABLE XIII

SAN FRANCISCO-OAKLAND BAY BRIDGE

MAINTENANCE PAINTING—SUMMARY OF PAINT USED

YEAR ENDING JUNE 30, 1938

Month	Bridge Painting				Harbor Piers		Miscellaneous Paint	Totals
	Lead Paints	Aluminum Paints	Bituminous Paints	Lacquer	Lead Paints	Bituminous Paints		
October	94	0	0	70	0	0	0	164
November	51½	0	0	0	0	0	7	58½
December	57½	0	0	0	0	0	16	73½
January	46	0	0	0	0	0	0	46
February	4	0	0	0	0	17½	4	25½
March	34	0	0	0	4	118½	2	158½
April	144	0	4	0	1	0	9½	158½
May	187	0	0	0	0	0	3½	190½
June	175½	127	18	0	0	0	6	326½
Totals	793½	127	22	70	5	136	48	1,201½

All quantities in gallons.
Aluminum paints expressed in gallons of vehicle.

TABLE XIV

SAN FRANCISCO-OAKLAND BAY BRIDGE

MAINTENANCE PAINTING—SUMMARY OF DELAYS DUE TO WEATHER—TIME IN HOURS

YEAR ENDING JUNE 30, 1938

Month	Working Days	Possible Painting Time Hours*	Cleaning Only Possible Hours	Lost Time Hours	Total Hours
October	20	115	45	0	160
November	20	111	49	0	160
December	22	71	76	29	176
January	21	61	99	8	168
February	19	19	74	59	152
March	23	40	137	7	184
April	21	150	14	4	168
May	21	143	25	0	168
June	22	165	11	0	176
Totals	189	875	530	107	1,512
Percentage		57.8	35.1	7.1	100

These figures based on five eight-hour working days per week, excepting holidays.
* Refers to bridge painting only.

PICTORIAL PROGRESS

BRIDGE RAIL CONSTRUCTION

INDEX TO PROGRESS PICTURES

Page

San Francisco Terminal, General Construction (Contract No. R-2A) 1A, 2A, 3A, 4A
San Francisco Terminal, Structural Steel (Contract No. R-2B) 4A
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Substructure, East Bay Yard (Contract No. R-4) 6A
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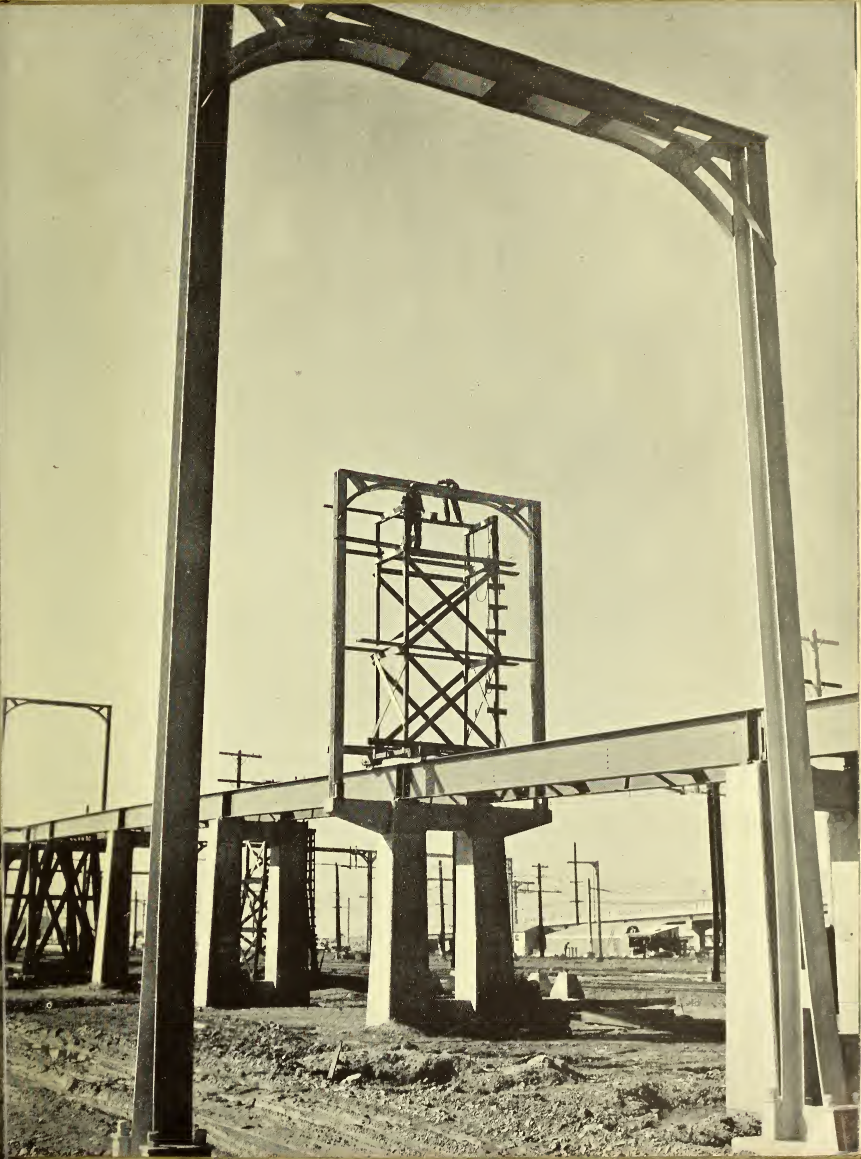
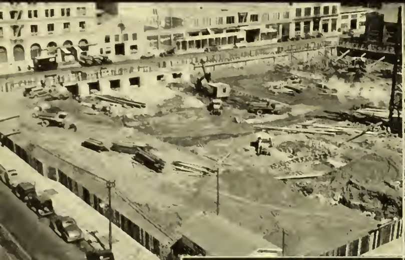
Track Work, Bridge and Viaduct (Contract No. R-9) 9A
East Bay Yard, Key System Work (Contract No. R-21) 10A
Track Work, East Bay Yard (Contract No. R-21A) 10A
Track Bonding, East Bay Yard (Contract No. R-21B) 11A
Catenary Bridges, East Bay Yard (Contract No. R-21C) 11A



CONTRACT R-2A — SAN FRANCISCO TERMINAL, GENERAL CONSTRUCTION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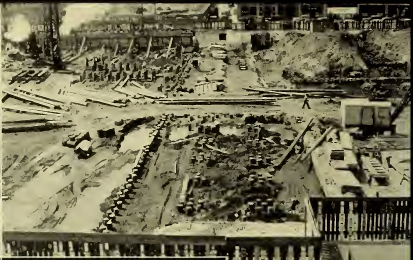
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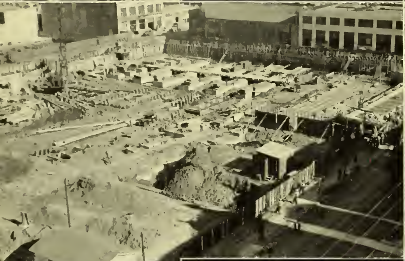
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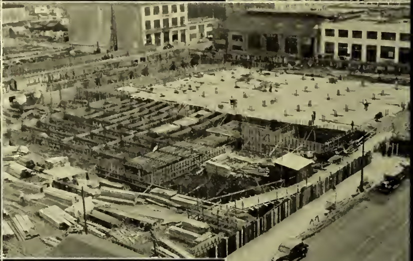
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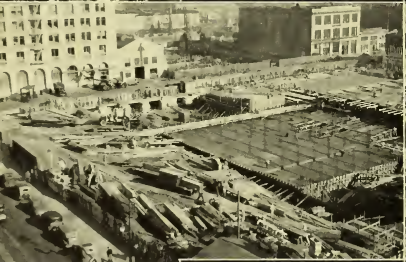
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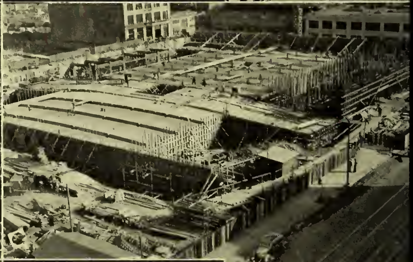
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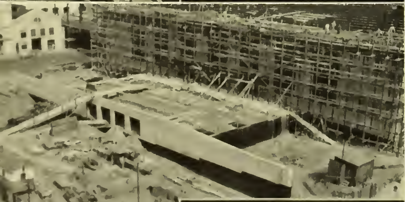
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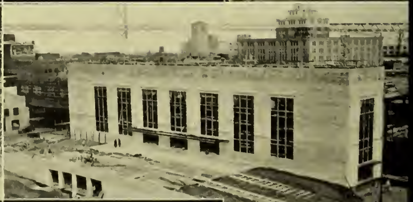
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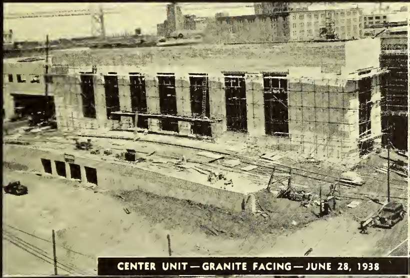
CONTRACT R-2A — SAN FRANCISCO TERMINAL, GENERAL CONSTRUCTION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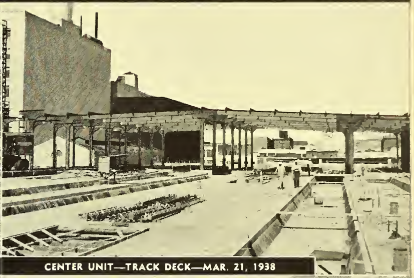
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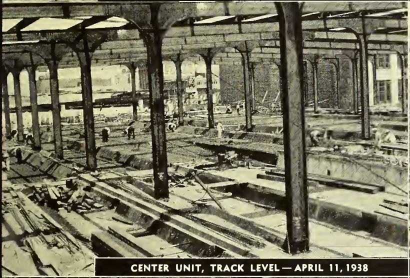
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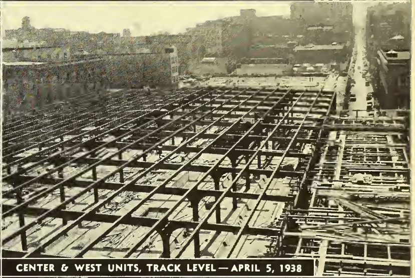
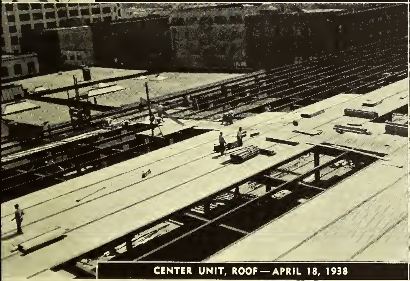

CENTER & WEST UNITS, TRACK LEVEL — APRIL 5, 1938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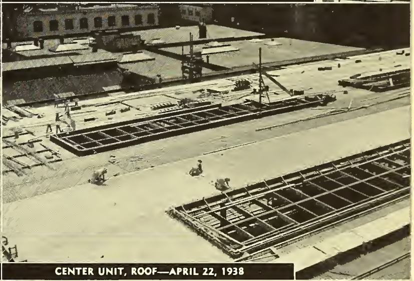
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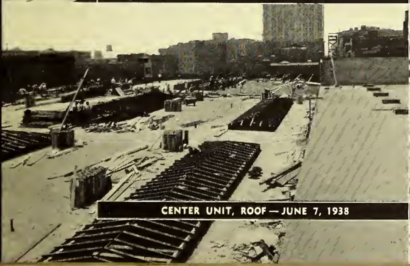
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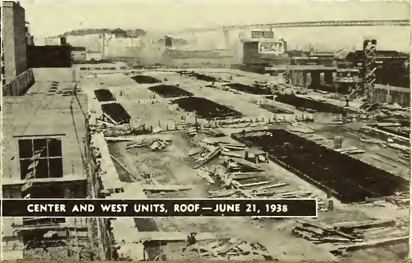
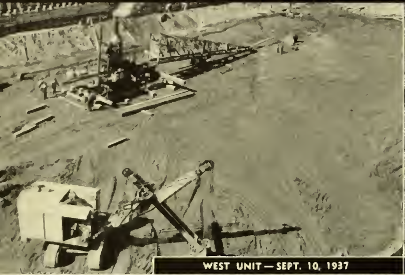

CENTER AND WEST UNITS, ROOF — JUNE 21, 1938

CONTRACT R-2A — SAN FRANCISCO TERMINAL, GENERAL CONSTRUCTION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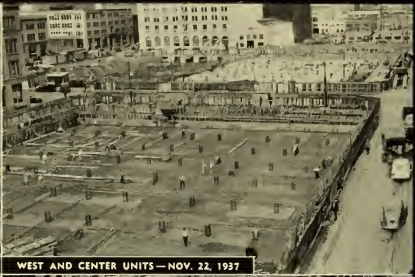
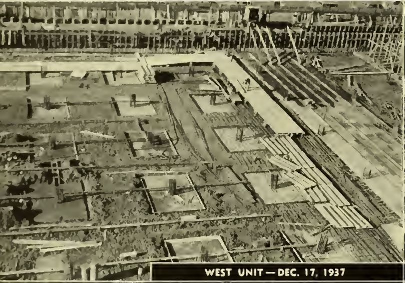

WEST AND CENTER UNITS—NOV. 22, 1937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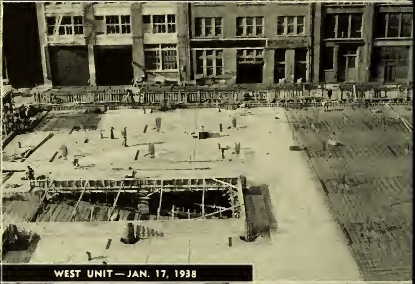
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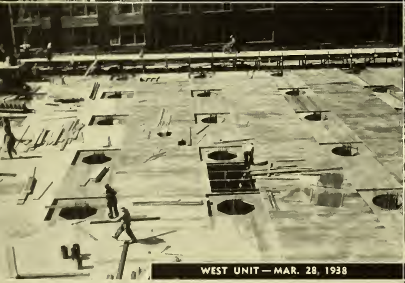
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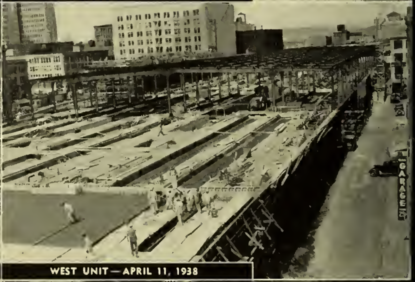

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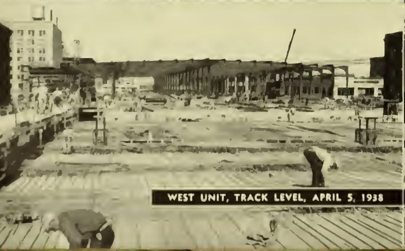
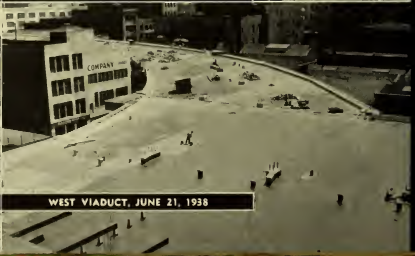
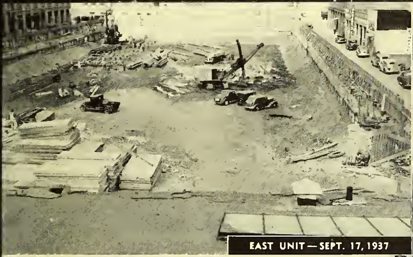
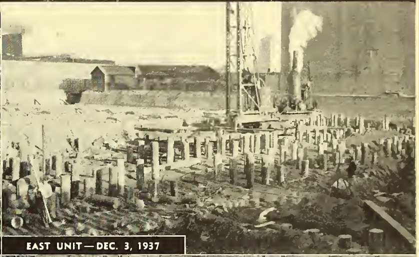

WEST UNIT, TRACK LEVEL, APRIL 5, 1938



WEST VIADUCT, JUNE 21, 1938

CONTRACT R-2A — SAN FRANCISCO TERMINAL, GENERAL CONSTRUCTION


EAST UNIT — SEPT. 17, 1937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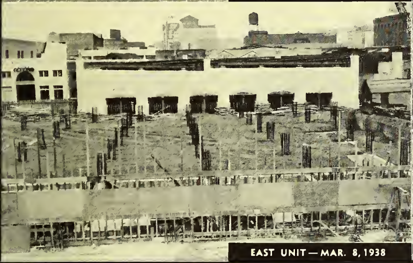
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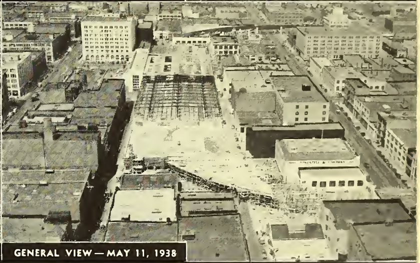
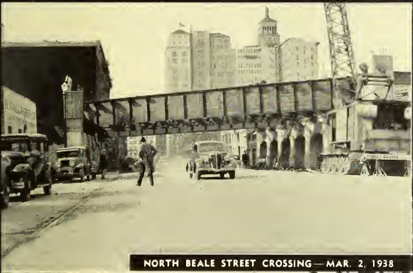
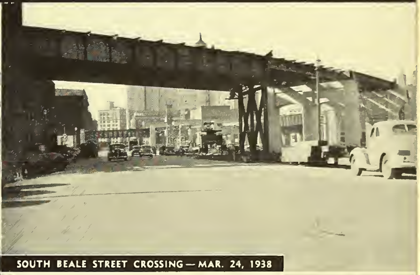
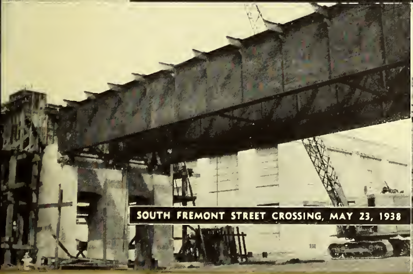
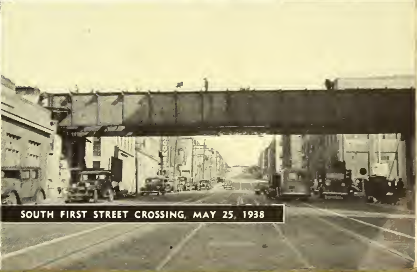

GENERAL VIEW — MAY 11, 1938

CONTRACT R-2B — SAN FRANCISCO TERMINAL, STRUCTURAL STEEL

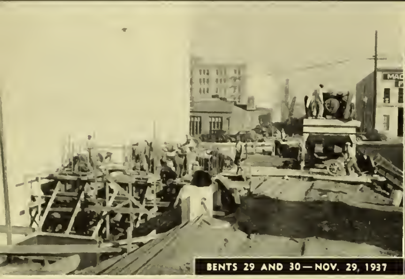

NORTH BEALE STREET CROSSING — MAR. 2, 1938


SOUTH BEALE STREET CROSSING — MAR. 24, 1938

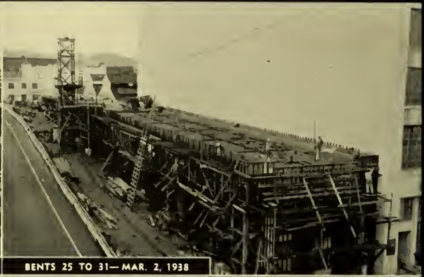

SOUTH FREMONT STREET CROSSING, MAY 23, 1938


SOUTH FIRST STREET CROSSING, MAY 25, 1938

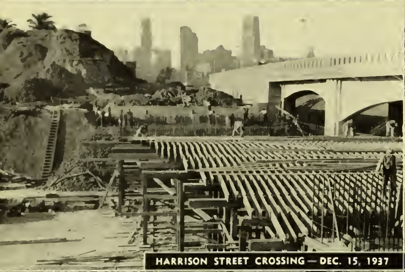
CONTRACT R-3 — SAN FRANCISCO VIADUCT



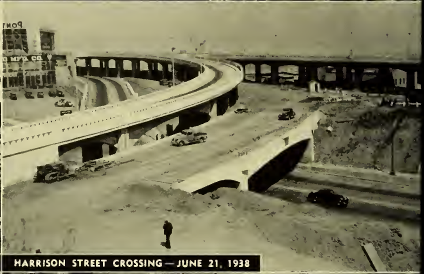
BENTS 29 AND 30—NOV. 29, 1937



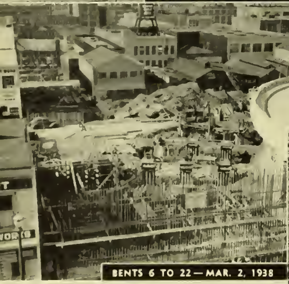
BENTS 25 TO 31—MAR. 2, 1938



HARRISON STREET CROSSING—DEC. 15, 1937



HARRISON STREET CROSSING—JUNE 21, 1938



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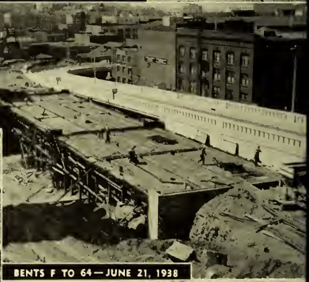

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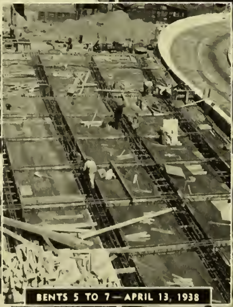
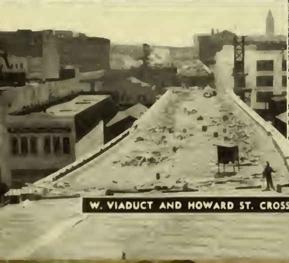
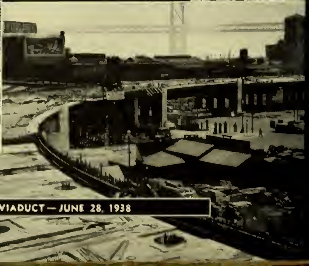


BENTS 5 TO 7—APRIL 13, 1938

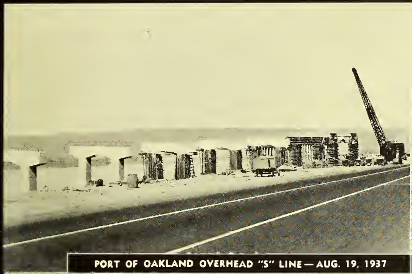


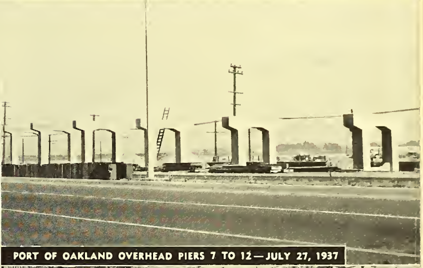
W. VIADUCT AND HOWARD ST. CROSSING—JUNE 7, 1938

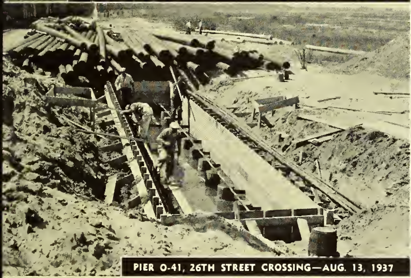


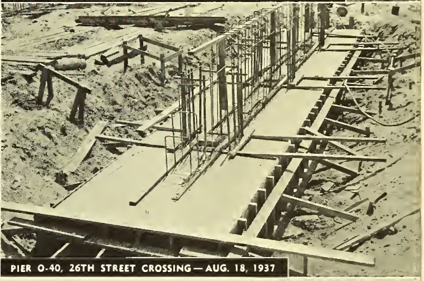
EAST VIADUCT—JUNE 28, 1938

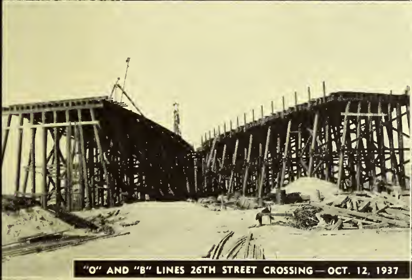
CONTRACT R-4 – SUBSTRUCTURE, EAST BAY YARD

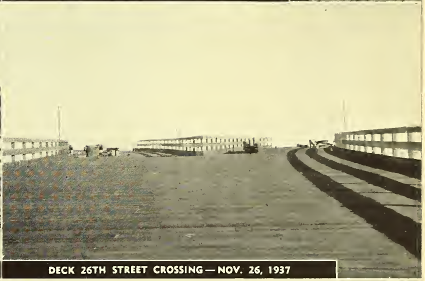

PORT OF OAKLAND OVERHEAD "S" LINE — AUG. 19, 1937

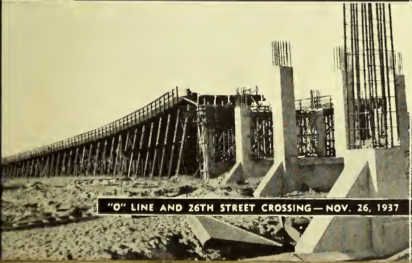

PORT OF OAKLAND OVERHEAD PIERS 7 TO 12 — JULY 27, 1937

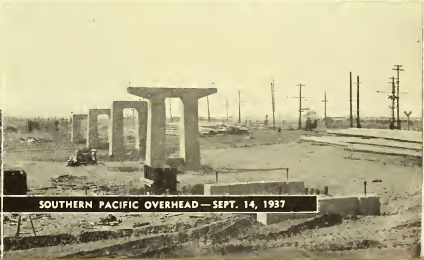

PIER O-41, 26TH STREET CROSSING — AUG. 13, 1937


PIER O-40, 26TH STREET CROSSING — AUG. 18, 1937

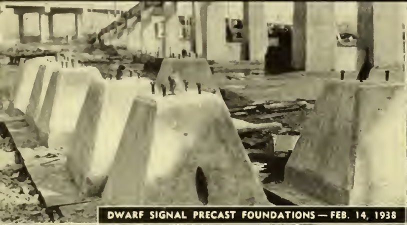

"O" AND "B" LINES 26TH STREET CROSSING — OCT. 12, 1937


DECK 26TH STREET CROSSING — NOV. 26, 1937

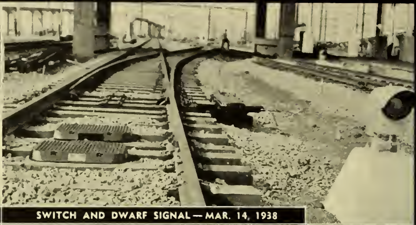

"O" LINE AND 26TH STREET CROSSING — NOV. 26, 1937


SOUTHERN PACIFIC OVERHEAD — SEPT. 14, 1937

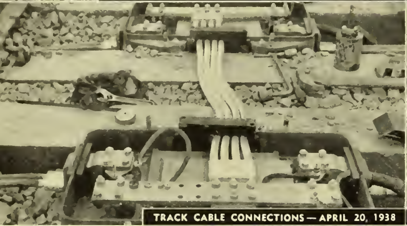
CONTRACT R-5—SIGNALS AND INTERLOCKING



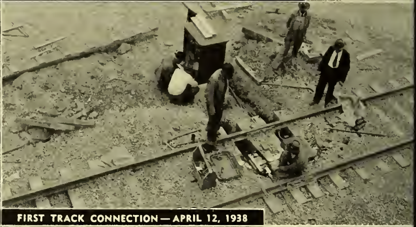
DWARF SIGNAL PRECAST FOUNDATIONS — FEB. 14, 1938



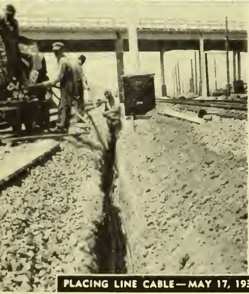
SWITCH AND DWARF SIGNAL — MAR. 14, 1938



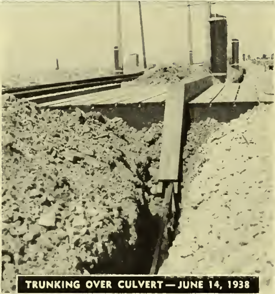
TRACK CABLE CONNECTIONS — APRIL 20, 1938



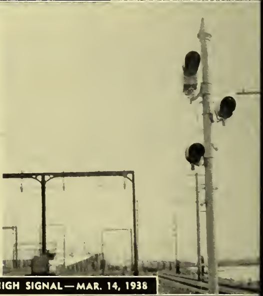
FIRST TRACK CONNECTION — APRIL 12, 1938



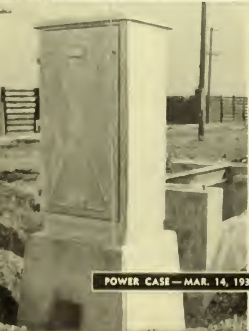
PLACING LINE CABLE — MAY 17, 1938



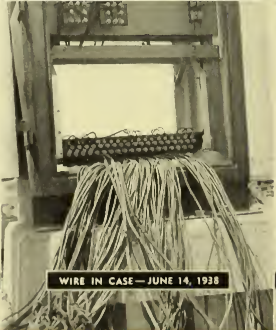
TRUNKING OVER CULVERT — JUNE 14, 1938



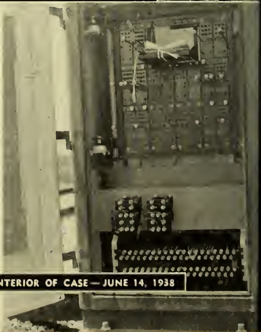
HIGH SIGNAL — MAR. 14, 1938



POWER CASE — MAR. 14, 1938

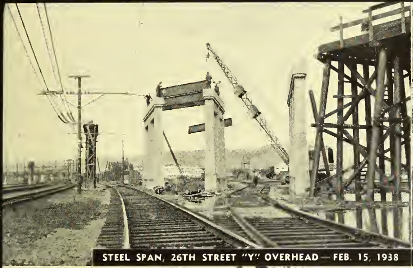


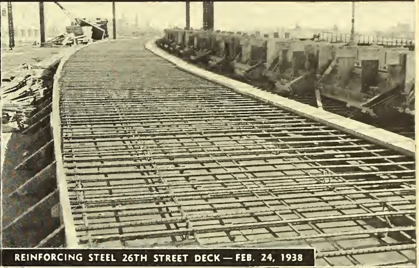
WIRE IN CASE — JUNE 14, 1938

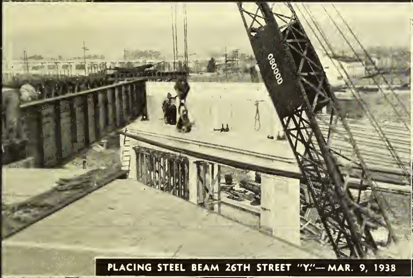


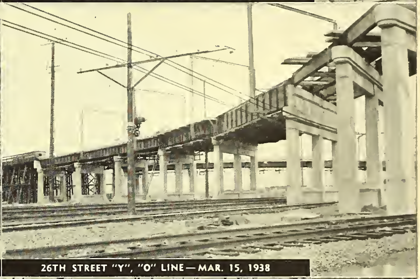
INTERIOR OF CASE — JUNE 14, 1938

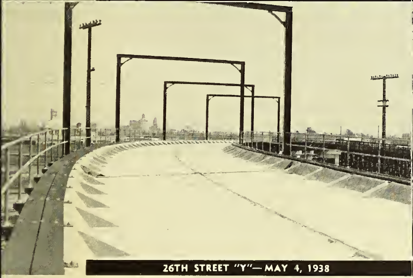
CONTRACT R-7 — SUPERSTRUCTURE, EAST BAY YARD

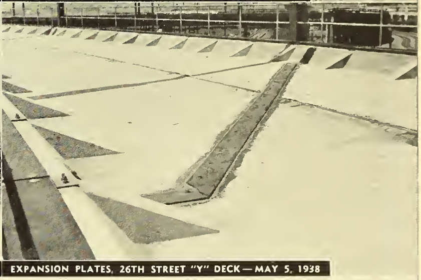

STEEL SPAN, 26TH STREET "Y" OVERHEAD — FEB. 15, 1938

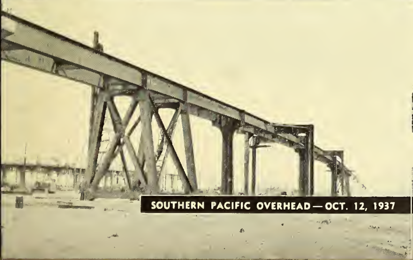

REINFORCING STEEL 26TH STREET DECK — FEB. 24, 1938

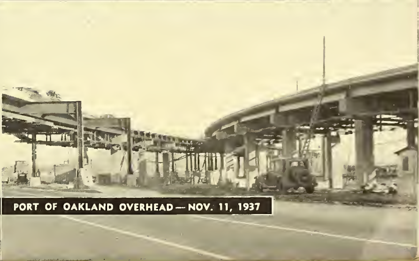

PLACING STEEL BEAM 26TH STREET "Y." — MAR. 9, 1938


26TH STREET "Y", "O" LINE — MAR. 15, 1938

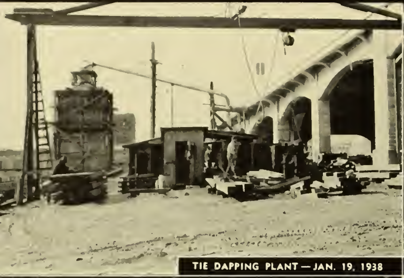

26TH STREET "Y" — MAY 4, 1938

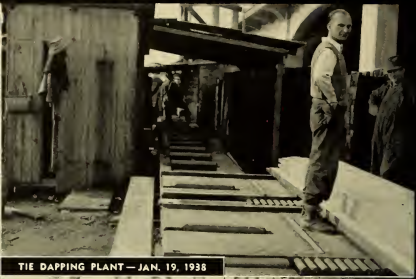

EXPANSION PLATES, 26TH STREET "Y" DECK — MAY 5, 1938

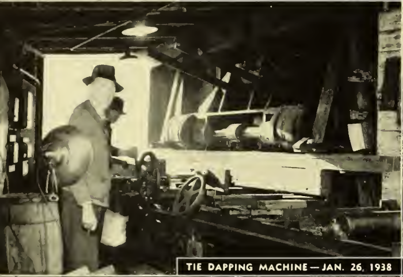

SOUTHERN PACIFIC OVERHEAD — OCT. 12, 1937

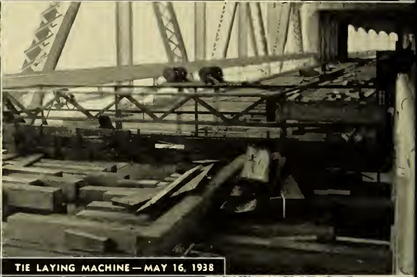

PORT OF OAKLAND OVERHEAD — NOV. 11, 1937

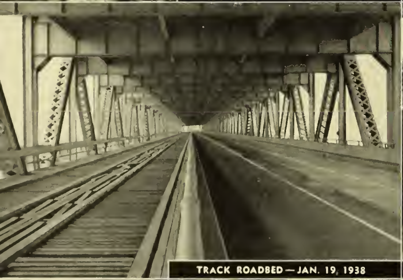
CONTRACT R-9— TRACKWORK, BRIDGE AND VIADUCT

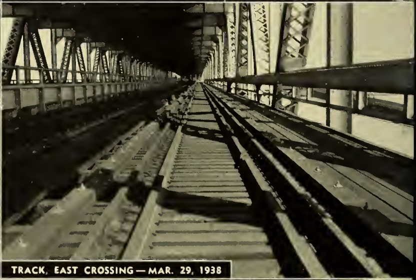

TIE DAPPING PLANT—JAN. 19, 1938

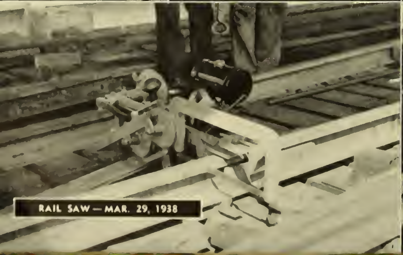

TIE DAPPING PLANT—JAN. 19, 1938

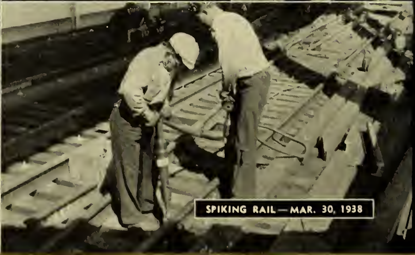

TIE DAPPING MACHINE—JAN. 26, 1938


TIE LAYING MACHINE—MAY 16, 1938

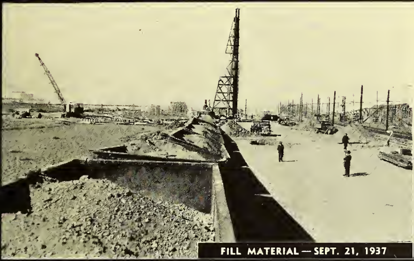

TRACK ROADBED—JAN. 19, 1938

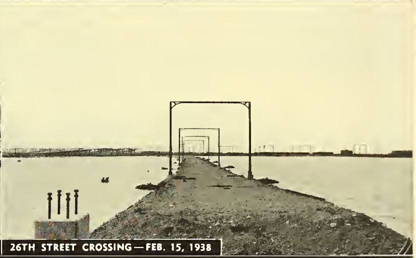

TRACK, EAST CROSSING—MAR. 29, 1938


RAIL SAW—MAR. 29, 1938

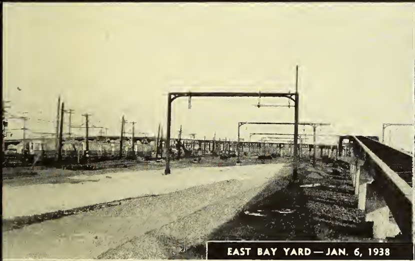

SPIKING RAIL—MAR. 30, 1938

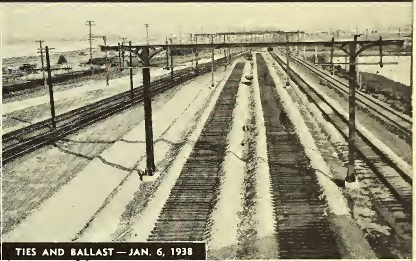
CONTRACT R-21 — EAST BAY YARD (Key System Work)

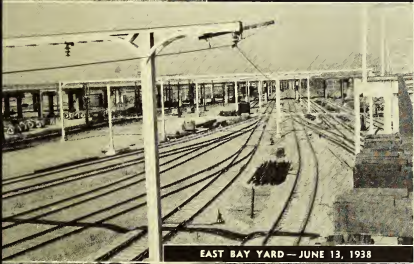

FILL MATERIAL — SEPT. 21, 1937

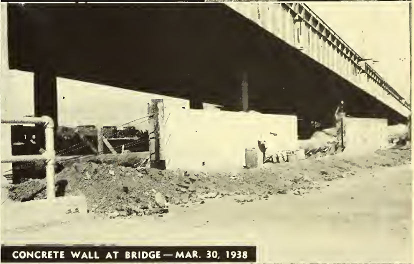

26TH STREET CROSSING — FEB. 15, 1938

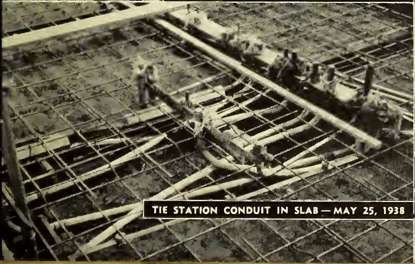
CONTRACT R-21A — TRACKWORK, EAST BAY YARD

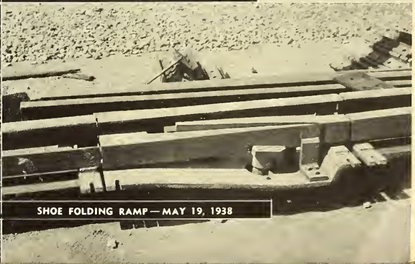

EAST BAY YARD — JAN. 6, 1938


TIES AND BALLAST — JAN. 6, 1938

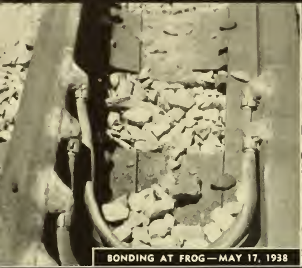

EAST BAY YARD — JUNE 13, 1938

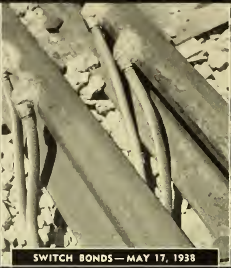

CONCRETE WALL AT BRIDGE — MAR. 30, 1938

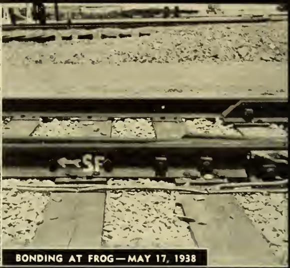

TIE STATION CONDUIT IN SLAB — MAY 25, 1938


SHOE FOLDING RAMP — MAY 19, 1938

CONTRACT R-21B — TRACK BONDING, EAST BAY YARD

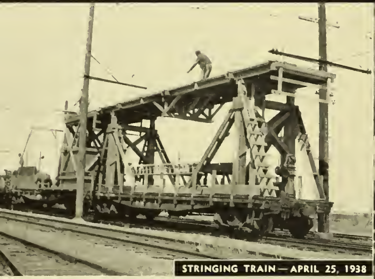

BONDING AT FROG—MAY 17, 1938

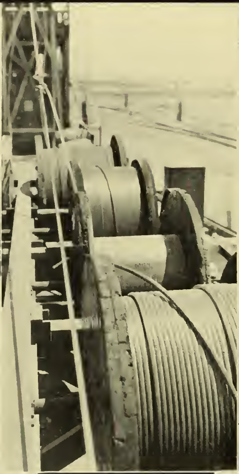

SWITCH BONDS—MAY 17, 1938

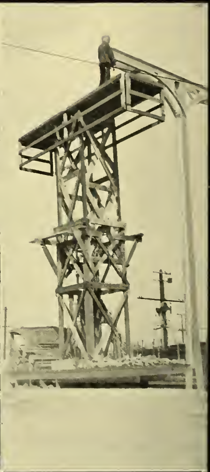


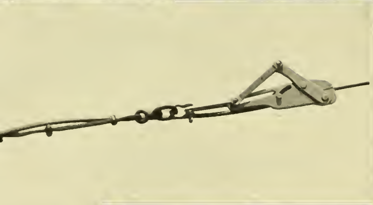
BONDING AT FROG—MAY 17, 1938

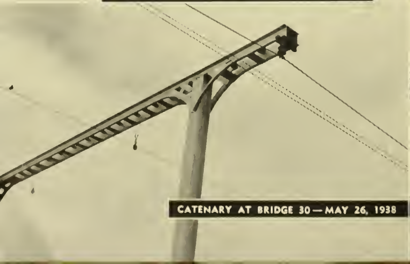
CONTRACT R-21C — CATENARY, EAST BAY YARD

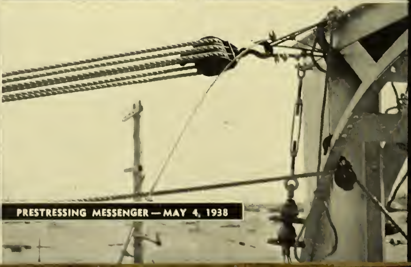

STRINGING TRAIN—APRIL 25, 1938


CABLE REELS—MAY 17, 1938


TOWER TRUCK—APRIL 25, 1938


HOLDBACK IN CABLE STRINGING—MAY 17, 1938


CATENARY AT BRIDGE 30—MAY 26, 1938


PRESTRESSING MESSENGER—MAY 4, 1938

APPENDIX

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS

SAN FRANCISCO-OAKLAND BAY BRIDGE

BIDS OPENED 2:00 P.M. AUGUST 18, 1937
RM. 811 - 500 SANSOME ST., SAN FRANCISCO

RAILWAY FACILITIES
SAN FRANCISCO VIADUCT
CONTRACT Nº R3

TABULATION OF BIDS

	EATON & SMITH	BATES & ROGERS CONST. CO.	CLINTON CONST. CO. OF CALIFORNIA	HEALY TIBBITTS CONST. CO.	BARRETT & HILP AND A. TEICHERT & SON, INC.	MACDONALD & KAHN CO. LTD.
	715 OCEAN AVE. SAN FRANCISCO	3401 WOOD ST. OAKLAND	923 FOLSOM ST. SAN FRANCISCO	1 DRUMM ST. SAN FRANCISCO	918 HARRISON ST. SAN FRANCISCO	FINANCIAL CENTER BLDG. SAN FRANCISCO.
BIDDERS BOND	$ 65.000 00	$ 75.000 00	$ 100.000 00		$ 100.000 00	$ 100.000 00
CERTIFIED CHECK				$ 75.000 00		

ITEM	APPROXIMATE QUANTITY	DESCRIPTION	EATON & SMITH		BATES & ROGERS CONST. CO.		CLINTON CONST. CO. OF CALIFORNIA		HEALY TIBBITTS CONST. CO.		BARRETT & HILP AND A. TEICHERT & SON, INC.		MACDONALD & KAHN CO. LTD.	
			UNIT PRICE	TOTAL	UNIT PRICE	TOTAL	UNIT PRICE	TOTAL	UNIT PRICE	TOTAL	UNIT PRICE	TOTAL	UNIT PRICE	TOTAL
1		Demolition and Removal of Buildings, Lump Sum.		2,600 00		3,700 00		5,900 00		4,000 00		5,500 00		20,200 00
2	20,000	Cubic Yards Excavation, Unclassified.	1 18	23,600 00	50	10,000 00	53	10,600 00	60	12,000 00	65	13,000 00	71	14,200 00
3	15,000	Cubic Yards Excavation, Structure	2 36	35,400 00	2 80	42,000 00	3 80	57,000 00	3 60	54,000 00	5 50	82,500 00	3 00	45,000 00
4	50	Each Cutting off Existing Piles.	4 00	200 00	7 00	350 00	2 00	100 00	1 50	75 00	2 50	125 00	1 90	95 00
5	45,000	Lineal Feet Timber Piles	73	32,850 00	615	27,675 00	58	26,100 00	60	27,000 00	70	31,500 00	77	34,650 00
6	10,000	Lineal Feet Concrete Piles	3 12	31,200 00	2 65	26,500 00	2 75	27,500 00	3 00	30,000 00	3 00	30,000 00	2 55	25,500 00
7	4,500	Cubic Yards Concrete in Foundations.	7 50	33,750 00	10 00	45,000 00	9 40	42,300 00	10 00	45,000 00	10 00	45,000 00	12 80	57,600 00
8	12,500	Cubic Yards Concrete above Foundations.	15 30	191,250 00	19 85	248,125 00	20 00	250,000 00	21 50	268,750 00	21 00	262,500 00	23 65	295,625 00
9	1,400	Cubic Yards Concrete Deck on Steel Spans.	21 80	30,520 00	21 45	30,030 00	20 00	28,000 00	21 00	29,400 00	21 00	29,400 00	23 65	33,110 00
10	2,500	Barrels Extra Portland Cement.	2 32	5,800 00	1 95	4,875 00	2 00	5,000 00	2 00	5,000 00	2 20	5,500 00	2 00	5,000 00
11	3,300,000	Pounds Reinforcing Steel.	05	165,000 00	0458	151,140 00	049	161,700 00	052	171,600 00	048	158,400 00	045	148,500 00
12	100,000	Pounds Miscellaneous Steel work.	10	10,000 00	185	18,500 00	09	9,000 00	10	10,000 00	10	10,000 00	10	10,000 00
13	4,200	Pounds Bronze Expansion Plates.	50	2,100 00	51	2,142 00	37	1,554 00	40	1,680 00	40	1,680 00	71	2,982 00
14	100,000	Pounds Pipe Railing.	17	17,000 00	168	16,800 00	175	17,500 00	17	17,000 00	15	15,000 00	18	18,000 00
15		Waterproofing Deck. Lump Sum		7,600 00		6,470 00		7,000 00		7,500 00		6,100 00		7,612 00
16		Drainage. Lump Sum		12,080 00		14,400 00		17,300 00		16,000 00		11,000 00		12,307 00
17		Street Work. Lump Sum		4,400 00		3,800 00		4,300 00		3,500 00		5,500 00		2,956 00
		TOTAL		$ 605.350 00		$ 651.507 00		$ 670854 00		$ 702505 00		$ 712.705 00		$ 733337 00

A—San Francisco Viaduct (Contract No. R-3)

B

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS

SAN FRANCISCO-OAKLAND BAY BRIDGE
BIDS OPENED 2:00 P.M. SEPTEMBER 15 1937
RM. 811, 500 SANSOME ST., SAN FRANCISCO

RAILWAY FACILITIES
TRACKWORK AND CONTACT RAIL
CONTRACT R-9 — MAIN BRIDGE AND SAN FRANCISCO LOOP
CONTRACT R-21A — EAST BAY YARD

	APPROXIMATE QUANTITY	DESCRIPTION	PACIFIC BRIDGE CO. 333 KEARNY ST. SAN FRANCISCO				ROGERS, COPELAND, CASSELL AND BURGHART c/o D B CASSELL AZUSA - CALIF				MACDONALD & KAHN COMPANY, LTD. 200 FINANCIAL CENTER BLDG SAN FRANCISCO				EATON & SMITH 715 OCEAN AVE. SAN FRANCISCO			
			BIDDERS BOND	$ 55.000 00			$ 60 000 00				$ 150000 00				R9-$ 75000 00		R21A $ 50000 00	
			CERTIFIED CHECK															
			UNIT PRICE	TOTAL	UNIT PRICE	TOTAL	UNIT PRICE	TOTAL	UNIT PRICE	TOTAL	UNIT PRICE	TOTAL	UNIT PRICE	TOTAL	UNIT PRICE	TOTAL	UNIT PRICE	TOTAL
		CONTRACT R-9 - MAIN BRIDGE AND SAN FRANCISCO LOOP																
1	170.000	Pounds Structural Steelwork	15	25500 00			165	28.050 00					22	37.400 00	22	37400 00		
2		Painting Structural Steel work — Lump Sum		17.440 00				12 935 00						39 000 00		1.000 00		
3	2.720	M.B.M. Framing and Placing Bridge Ties	6 30	188.496 00			55 60	151 232 00					45 00	122 400 00	61 00	165.920 00		
4	235	M.B.M. Framing and Placing Spacing Blocks	6 00	14 100 00			130 00	30.550 00					52 00	12.220 00	118 00	27730 00		
5	340	M.B.M. Framing and Placing Timber Guardrails	4 00	15.980 00			93 50	31.790 00					52 00	17.680 00	80	27.200 00		
6	400	M.B.M. Framing and Placing Walkways, etc.	3 00	13200 00			50 00	20 000 00					45 00	18.000 00	66	26.400 00		
7	3800	Tons Ballast - Yerba Buena Island	50	13 300 00		AWARDED CONT. R-9	2 85	10 830 00					4 00	15.200 00	3 06	11.628 00		
8	3800	Tons Ballast - San Francisco Loop and Pier W4	50	17.100 00			2 85	10.830 00					3 40	12920 00	4 00	15.200 00		
9	10 247	Lineal Feet Double Track - Track laying East Bay Crossing	50	35 864 50			4 80	49.185 60					6 00	61482 00	6 50	66.605 50		
10	10 304	Lineal Feet Double Track - Track Laying West Bay Crossing	50	36.064 00			5 45	56 156 80					5 00	51520 00	6 40	65.945 60		
11	1.798	Lineal Feet Double Track - Track Laying Yerba Buena Island	00	7192 00			4 90	8.810 20					7 00	12.586 00	9 10	16.361 80		
12		Track Laying - San Francisco Loop. — Lump Sum		50.000 00				87.800 00						87.696 00		106 000 00		
13		Contact Rail and Protection Main Bridge and San Francisco Loop. — Lump Sum		35000 00				67.800 00						45.000 00		133.000 00		
		TOTAL PROPOSAL A		$ 469,236 50				$ 565,969 60						SUB-TOTAL $ 533,104 00		$ 700,390 90		
		CONTRACT R-21A - EAST BAY YARD																
14		Flange Protection of Steelwork. — Lump Sum						560 00						1,450 00		10900 00		
15	91	M.B.M. Framing and Placing Bridge Ties.					37 50	3412 50					45	4095 00	56 00	5,096 00		
16	45	M.B.M. Framing and Placing Other Floor Timbers					74 75	3.363 75					52	2.340 00	73 00	3.285 00		
17	6000	Cubic Yards Excavation.					55	3300 00					1	6000 00	34	2 040 00		
18	27.000	Tons Imported Fill.					1 20	32.400 00					1 50	40.500 00	1 50	40500 00		
19		Preparing Subgrade. — Lump Sum						9.100 00						11.000 00		13.600 00		
20		Yard Drainage. — Lump Sum						18 300 00						12.000 00		11.500 00		
21	100.000	Tons Ballast				AWARDED CONT. R-21A	1 91	191,000 00					2 00	200.000 00	1 90	190.000 00		
22		Track Laying — Lump Sum						143.250 00						150.000 00		162,329 00		
23		Contact Rail and Protection. — Lump Sum						10.450 00						9.000 00		20.000 00		
24	175	Cubic Yards Concrete					26 30	4.602 50					30 00	5.250 00	26 00	4.550 00		
25	30.000	Pounds Reinforcing Steel					07	2 100 00					10	3.000 00	06	1.800 00		
26	400	Tons Crusher Run Base					6 25	2500 00					4 00	1.600 00	3 00	1,200 00		
27	400	Tons Mineral Aggregate					7 50	3000 00					4 00	1.600 00	3 00	1.200 00		
28	30	Tons Stone Screenings					6 25	187 50					5 00	150 00	4 00	120 00		
29	15	Tons Type SC-2 Asphalt					22 50	337 50					30 00	450 00	22 00	330 00		
30	25	Tons Type MC-3 Asphalt.					20 00	500 00					30 00	750 00	22 00	550 00		
		TOTAL PROPOSAL B		$ 428,363 75				$ 428.363 75						SUB-TOTAL $ 449,185 00		$ 469,000 00		
		TOTAL PROPOSAL C												$ 982289 00				
		TOTAL PROPOSAL A - B		$ 897,600 25				$ 994,333 35								$ 1,169,390 90		

B—Track Work and Contact Rail, Main Bridge and San Francisco Loop (Contract No. R-9); East Bay Yard (Contract No. R-21A)

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS

SAN FRANCISCO-OAKLAND BAY BRIDGE

BIDS OPENED 2:00 P.M. JANUARY 26 1938
RM 811 · 500 SANSOME ST. SAN FRANCISCO

RAILWAY FACILITIES
CATENARY AND FEEDERS

CONTRACT R-10
MAIN BRIDGE AND SAN FRANCISCO LOOP

CONTRACT R-21C
EAST BAY YARD

BARRETT AND HILP
918 HARRISON STREET.
SAN FRANCISCO
BIDDERS BOND
CERTIFIED CHECK $ 40,000.00

ALTA·ELECT. AND MECH. CO.
467 O'FARRELL STREET
SAN FRANCISCO
$ 45,000.00

KENNY ELECTRIC CO.
7 FRONT STREET
SAN FRANCISCO
$ 45,000.00

RADELFINGER BROS.
544 NATOMA STREET
SAN FRANCISCO
$ 50,000.00

	APPROX. QUAN.	DESCRIPTION		BARRETT AND HILP UNIT $ (A / B)	BARRETT AND HILP TOTAL (A / B)	BARRETT AND HILP UNIT $ (C)	BARRETT AND HILP TOTAL (C)
CONTRACT R-10 MAIN BRIDGE AND SAN FRANCISCO LOOP					A		C
1		Feeder Cables at San Francisco Substation	Lump Sum		12800 00		12,000 00
2		Feeder Cables at Island Substation and Tie Station	Lump Sum		14,400 00		13,500 00
3		W·4 Tie Station	Lump Sum		12,000 00		11,200 00
4		Island Tie Station, Building and Equipment	Lump Sum		3,000 00		2,900 00
5		E7 Tie Station	Lump Sum		17,800 00		16,700 00
6	12	Disconnect Switches, 1200 Amp·Type K	per Switch	55 00	6,600 00	500 00	6,000 00
7	18	Disconnect Switches, Type R at S.F. Term & Anchorage	Lump Sum		7,600 00		7,100 00
8	5000	Lineal Feet Reinforcing Feeder Cable	per Lin. foot	34	1,700 00	32	1,600 00
9		Jumper Cables at Bridge Expansion Joints	Lump Sum		30,000 00		28,000 00
10	15,000	Pounds Miscellaneous Iron	per pound	34	5,100 00	32	4,800 00
11		Overhead Construction	Lump Sum		86,918 00		81,000 00
12		Power Line to San Francisco Terminal	Lump Sum		8,000 00		7,500 00
		TOTAL PROPOSAL A			$ 205,918 00		
CONTRACT R-21C EAST BAY YARD					B		
13		Feeder Cables at Mole Substation	Lump Sum		32,200 00		29,000 00
14		Yard Tie Station	Lump Sum		22,200 00		20,200 00
15		East End Tie Station	Lump Sum		24,000 00		22,000 00
16	7	Disconnect Switches, 1200 Amp. Type H	per Switch	700 00	4,900 00	700 00	4,900 00
17	6	Disconnect Switches, 1200 Amp. Type B, SPDT	per Switch	1100 00	6,600 00	1000 00	6,000 00
18	3	Disconnect Switches, 1200 Amp. Type R	Lump Sum		1,300 00		1,200 00
19		Connections 600 Volt Overhead to Contact Rail	Lump Sum		2,200 00		2,000 00
20	35000	Pounds Miscellaneous Iron	per pound	30	10,500 00	28	9,800 00
21		Overhead Construction	Lump Sum		84,875 00		75,683 00
22		Power Line to Inspection·Buildings	Lump Sum		7,800 00		7,200 00
		TOTAL PROPOSAL B			$196,575 00		
		TOTAL PROPOSAL C					$370,283 00
		TOTAL PROPOSAL A·B			$402,493 00		

	DESCRIPTION	ALTA·ELECT. AND MECH. CO. UNIT $ (A / B)	ALTA TOTAL (A / B)	ALTA UNIT $ (C)	ALTA TOTAL (C)	KENNY ELECTRIC CO. UNIT $ (A / B)	KENNY TOTAL (A / B)	KENNY UNIT $ (C)	KENNY TOTAL (C)	RADELFINGER BROS. UNIT $ (A / B)	RADELFINGER TOTAL (A / B)	RADELFINGER UNIT $ (C)	RADELFINGER TOTAL (C)
CONTRACT R-10			A		C		A		C		A		C
1	Feeder Cables at San Francisco Substation				11,650 00				14,664 00				13,842 00
2	Feeder Cables at Island Substation and Tie Station				12,300 00				12,843 00				13,298 00
3	W·4 Tie Station				9,500 00				16,576 00				11,648 00
4	Island Tie Station, Building and Equipment				22,500 00				27,714 00				25,937 00
5	E7 Tie Station				14,300 00				21,301 00				15,864 00
6	Disconnect Switches, 1200 Amp·Type K			400 00	4,800 00			460 00	5,520 00			378 00	4,536 00
7	Disconnect Switches, Type R at S.F. Term & Anchorage				7,000 00				9,261 00				8,522 00
8	Lineal Feet Reinforcing Feeder Cable			44	2,200 00			18	900 00			87	4,350 00
9	Jumper Cables at Bridge Expansion Joints				32,000 00				35,810 00				27,450 00
10	Pounds Miscellaneous Iron			43	6,450 00			81	12,150 00			54	8,100 00
11	Overhead Construction				70,000 00				56,714 00				76,255 00
12	Power Line to San Francisco Terminal				7,400 00				8,649 00				7,120 00
	TOTAL PROPOSAL A												
CONTRACT R-21C			B				B				B		
13	Feeder Cables at Mole Substation				25,000 00				26,349 00				22,658 00
14	Yard Tie Station				17,000 00				20,808 00				15,934 00
15	East End Tie Station				19,000 00				25,594 00				20,758 00
16	Disconnect Switches, 1200 Amp. Type H			430 00	3,010 00			457 00	3,199 00			458 00	3,206 00
17	Disconnect Switches, 1200 Amp. Type B, SPDT			800 00	4,800 00			810 00	4,860 00			856 00	5,136 00
18	Disconnect Switches, 1200 Amp. Type R				1,250 00				1,659 00				958 00
19	Connections 600 Volt Overhead to Contact Rail				1,200 00				2202 00				1,050 00
20	Pounds Miscellaneous Iron			43	15,050 00			81	28,350 00			54	18,900 00
21	Overhead Construction				91,000 00				52,497 00				90,696 00
22	Power Line to Inspection·Buildings				7,000 00				7,300 00				7,627 00
	TOTAL PROPOSAL B												
	TOTAL PROPOSAL C				$384,410 00				$ 394,920 00				$403,845 00
	TOTAL PROPOSAL A·B												

C—Catenary and Feeders, Main Bridge and San Francisco Loop (Contract No. R-10); East Bay Yard (Contract No. R-21C)

D—Bonding Track Work and Contact Rail, Main Bridge and San Francisco Loop (Contract No. R-11); East Bay Yard (Contract No. R-21B)

D

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
SAN FRANCISCO-OAKLAND BAY BRIDGE
BIDS OPENED 2:00 P.M. SEPTEMBER 15, 1937
RM. 811 500 SANSOME ST., SAN FRANCISCO

RAILWAY FACILITIES
BONDING TRACKWORK AND CONTACT RAIL

CONTRACT R-11
MAIN BRIDGE AND SAN FRANCISCO LOOP

CONTRACT R-21B
EAST BAY YARD

TABULATION OF BID

GENERAL WELDING CO.
954 HOWARD ST.,
SAN FRANCISCO

BIDDERS BOND $5000.00
CERTIFIED CHECK

	APPROXIMATE QUANTITY	DESCRIPTION	UNIT PRICE		TOTAL	
		CONTRACT R-11 MAIN BRIDGE AND SAN FRANCISCO LOOP				
1	16,000	13-½ inch. 250 000 c.m. bonds.		66	10,560	00
2	110	250 000 c.m. bonds of special trackwork		75	82	50
3	1,070	350,000 c.m. bonds. lengths from 3 feet to 6 feet.		85	909	50
4	590	350 000 c.m. bonds. lengths from 7 feet to 19 feet.	1	10	649	00
5	70	350,000 c.m bonds. lengths from 20 feet to 40 feet.	1	30	91	00
6	390	#2-A.W.G. bonds		60	234	00
7	155	Negative feeder taps		90	139	50
8	4,700	Lineal feet 1,000,000 cm jumper cable connecting bet negative feeder taps.		16	752	00
9	5,000	Lineal feet 500,000 c.m. cross bond cable.		12	600	00
10	1,180	Welding and bonding 150-pound contact rail joints	4	75	5,605	00
11	1,240	11-inch. 4/0 bonds		66	818	40
12	165	1,000,000-c.m cone terminals	1	50	247	50
13	65	500,000 c.m. cone terminals	1	15	74	75
14	10	Units spark gaps and connections	4	25	42	50
15	335	500,000-c.m contact rail jumbers. lengths from 8 feet to 16 feet	2	25	753	75
16	135	500,000-c.m. contact rail jumpers. lengths from 16 feet to 38 feet	2	75	371	25
					$ 21,930.65	
		CONTRACT R-21B - EAST BAY YARD				
17	8,200	13-½ inch. 250,000-c.m. bonds		78	6,396	00
18	250	250,000-c.m. bonds of special trackwork		84	210	00
19	650	350,000-c.m. bonds lengths from 3 feet to 6 feet		90	585	00
20	350	350,000-c.m bonds lengths from 7 feet to 19 feet	1	15	402	50
21	90	350,000-c.m bonds lengths from 20 feet to 40 feet	1	40	126	00
22	150	#2-A.W.G. bonds		75	112	50
23	- 80	Negative feeder taps		90	72	00
24	3,000	Lineal feet 1,000,000 c.m. cross bond cables connecting to negative feeder taps		25	750	00
25	60	Units structure grounding bonds to ground rods	3	50	210	00
26	70	Units structure grounding bonds to yard rails	3	00	210	00
27	260	Welding and bonding 150 pound contact rail joints	4	50	1,170	00
28	130	11-inch. 4/0 bonds		78	101	40
29	15	1000,000-c.m. cone terminals	1	50	22	50
30	5	500,000-c.m cone terminals	1	15	5	75
31	55	500,000-c.m. contact rail jumper cables. lengths from 8 feet to 16 ft	2	75	151	25
32	22	500,000-c.m. contact rail jumper cables. lengths from 16 feet to 22 ft.	3	25	71	50
					$10,596	40
		TOTAL			$ 32,527.05	

D—Bonding Track Work and Contact Rail, Main Bridge and San Francisco Loop (Contract No. R-11); East Bay Yard (Contract No. R-21B)